SECTION 1

Introduction and Safety

INTRODUCTION AND SAFETY

Table of Contents

Operation No.	Description		Page No.
1A .1	Introduction	… … …	1A - 3
1A .2	Safety in workshop	… … …	1A - 5

1A .1 INTRODUCTION

The purpose of this manual is to assist Dealers and Distributors in the efficient repair and maintenance of MF2605/2615 farm tractors. Carrying out the procedures as detailed, together with the use of special tools where appropriate, will enable the operations to be completed within the time stated in the Repair Time Schedule.

To assist with locating information, each section of the manual is preceded by a contents page listing the operations. Each instruction within an operation has a sequence number, and to complete the operation in the minimum time it is essential that these instructions are performed in numerical sequence commencing at 1, unless otherwise stated.

When applicable, these sequence numbers identify the components in the appropriate illustration. When an operation requires the use of a special tool, the tool number is quoted under the operation heading and is repeated in, or following, the instruction involving its use.

Indexing

For convenience, the manual is divided into sections and parts, each page bearing a section and part number. The sections are subdivided into numbered operations

Definition of Terms

The operation description generally used throughout the schedules may be defined as follows :

Removed and Refitment

Remove and refit an original part or assembly, or a new part or assembly which does not involve additional operations or time

Install

Install a part or component not previously fitted e.g. accessories.

Overhaul

Remove a part or assembly, dismantle, inspect and recondition, re-assemble, and re-install making all necessary adjustments.

Dis-assembly and Re-assembly

The terms ‘Dis-assembly’ and ‘Re-assembly’ indicate the orderly taking apart of an assembly into individual parts and rebuilding it into the original assembly.

Adjust

Make the necessary adjustments to restore specified setting or performance.

Check

Ascertain if a setting or condition is within the limits of acceptability, either as defined in the manufacturer’s specifications or, where a dimension is not specified, in the judgement of the mechanic. The checking of fixings, e.g. nuts and bolts, includes tightening to the specified torque figures listed in this Manual

Servicing

All technical work undertaken to maintain the machine in working order.

Special Tools

Where the use of a special tool is specified in an operation the tool number will be shown under the operation heading and also following the instruction requiring its use.

The use of the special tools mentioned in the text contributes to a safe, efficient and profitable repair. Some operations are impracticable without their use, for example, the refitment of the differential unit. Distributors and Dealers are therefore urged to check their tools against the list provided.

Repairs and Replacement

When service parts are required it is essential that only MF2605/2615 genuine parts are used for replacement.

Attention is particularly drawn to the following points concerning repairs and the fitting of replacement parts and accessories.

1. Safety features embodied in the tractor may be impaired if other than genuine parts are fitted.

2. In certain territories, legislation prohibits the fitting of parts not to the tractor manufacturer's specification.
3. Torque wrench setting figures given in the Workshop Manual must be strictly adhered to.
4. Locking devices where specified must be fitted. If the efficiency of a locking device is impaired during removal it must be renewed.

The tractor warranty may be invalidated by the fitting of parts other than genuine MF2605/2615 parts. All MF2605/2615 replacements have the full backing of the manufacturer's warranty. MF2605/2615 Distributors and Dealers are obliged to supply only genuine service parts.

Repair of the Tractor

Follow these important points :

CLEAN THE TRACTOR AND DIAGNOSE THE FAULT BEFORE DIS-ASSEMBLY

If possible, make a complete diagnosis to determine the extent of the repair required. Take precautions, as necessary to prevent dirt or other foreign material entering the hydraulic, fuel or air systems.

DO NOT MIX PARTS

Make particular note of special parts which should not be interchanged.

DURING DIS-ASSEMBLY, CLEAN PARTS THOROUGHLY AND INSPECT THEM FOR WEAR, DAMAGE, ETC.

LABEL PARTS.

PROTECT PRECISION OR MACHINED SURFACES.

SAFETY ALERT SYMBOL AND TERMS

SAFETY ALERT SYMBOL

This is the safety alert symbol. It means ATTENTION! BECOME ALERT! SAFETY IS INVOLVED! Look for it, both in this manual and on safety signs on the tractor. It will direct your attention to information that involves your safety and the safety of others.

SIGNAL WORDS

The words **DANGER, WARNING** or **CAUTION** are used with the safety alert symbol. Learn to recognize these safety alerts and follow the recommended precautions and safe practices.

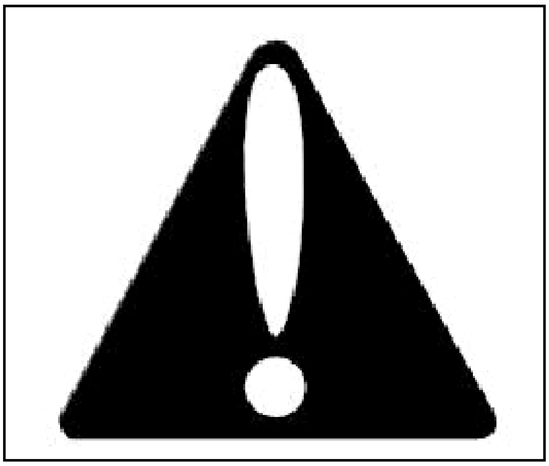
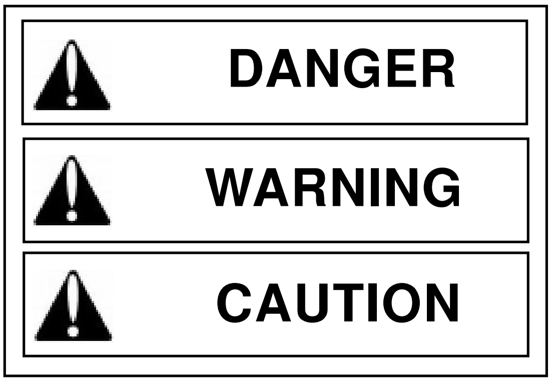


Fig 1



DANGER: Indicates an imminently hazardous situation that, if not avoided, will result in DEATH OR VERY SERIOUS INJURY.

WARNING: Indicates a potentially hazardous situation that, if not avoided, could result in DEATH OR SERIOIUS INJURY.

CAUTION: Indicates a potentially hazardous situation that, if not avoided, may result in MINOR INJURY.

INFORMATIONAL MESSAGES

The words ***IMPORTANT*** and ***NOTE*** are not related to personal safety, but are used to give additional information and tips for operating or servicing the equipment.

IMPORTANT: IMPORTANT: *Identifies special instructions or procedures that, if not strictly observed,could result in damage to, or destruction of the tractor, attachments or the environment.*

NOTE: *Identifies points of particular interest for more efficient and convenient operation or repair.*

1A .2 SAFETY IN THE WORKSHOP

This safety section of your Workshop Service manual is intended to point out some of the basic safety situations which may be encountered during the normal repair operations of the tractor, and to suggest possible ways of dealing with these situations.

Additional precautions may be necessary, depending on the type of repair and the conditions at the work site or in the workshop. MF2605/2615 has no direct control over the repair procedures, operation, inspection, lubrication or general maintenance. Therefore it is YOUR responsibility to use good safety practices in these areas.

Safety – a word to the Mechanic

It is your responsibility to read and understand this safety section before carrying out repairs on MF2605/2615 equipment.

Remember that YOU are the key to safety. Good safety practices not only protect you, but also the people around you. Study the features in this section and the rest of the manual and make them a working part of your safety programme. Practice all other usual and customary safe working precautions, and above all – REMEMBER - SAFETY IS YOUR RESPONSIBILITY. YOU CAN PREVENT SERIOUS INJURY OR DEATH.

SAFETY SIGN

WARNING : DO NOT remove or obscure Danger, Warning or Instruction sign.

Replace any Danger, Warning, Caution or Instruction sign that are not readable, damaged or are missing.

GENERAL

Practically all service work involves the need to drive a tractor. The Operator Instruction Book, supplied with each tractoror implement, contains detailed safety precautions relating to driving, operating and servicing. These precautions are as applicable to the service mechanic as they are to the operator, and should be read, understood and practised by all personnel.

Prior to undertaking any maintenance, repair, overhaul, dismantling or re-assembly operations, whether within a workshop facility or out in the field, consideration should be given to factors that may have an effect upon Safety, not only upon the mechanic carrying out the work, but also upon bystanders.

- DO NOT allow children or bystanders around or on the machine while it is being adjusted, serviced, repaired or operated.

PERSONAL CONSIDERATIONS

Clothing

- The wrong clothes or carelessness in dress can result in entanglement in moving parts. Check to see that you are suitably clothed. DO NOT wear loose clothing or long hair around equipment.

  Some jobs require special protective equipment.

Eye Protection

- The smallest eye injury may cause loss of vision. Injury can be avoided by wearing the proper eye protection when engaged in chiselling, grinding, sanding, welding, painting etc.
- Wear safety goggles or safety glasses appropriate to the job in hand.

Breathing Protection

- Fumes,dust and paint spray are unpleasant and harmful. These can be avoided by wearing respiratory protection.

Hearing Protection

- Loud noise may damage your hearing. Longer the exposure greater the damage. Wear ear protection.

Hand Protection

- It is advisable to use a protective barrier cream before work to prevent irritation and skin contamination. After work clean your hands in soap and water. Solvents such as white spirit, paraffin, etc., may harm the skin.
- Wear gloves when ever possible to protect your hands. DO NOT wear rings or wrist watches when working on machinery, as they could catch on moving parts and cause serious injury.

Foot Protection

- Substantial or protective footwear with reinforced toe-caps (safety shoes) will protect your feet from falling objects. Additionally, oil-resistant soles will help to avoid slipping.

Special Clothing

- For certain work it may be necessary to wear flame or acid-resistant clothing.

EQUIPMENT CONSIDERATIONS

Machine Guards

- Before using any machine, check to ensure that the machine guards are in position and serviceable. These guards not only prevent parts of the body or clothing coming in contact with the moving parts of the machine, but also ward off objects that might fly off the machine and cause injury. Ensure that missing guards are replaced.

Lifting Appliances

- Always ensure that lifting equipment, such as chains, slings, lifting brackets, hooks and eyes are thoroughly checked before use. If in doubt, select stronger equipment than is necessary.
- Never stand under a suspended load or raised implement.
- Avoid injury through incorrect handling of components. Make sure you are capable of lifting the object. If in doubt get help.

Jacking

- Select a jack strong enough to carry the load.
- Stabilize the tractor and chock the wheels.
- Put support stands under the tractor. Lower the jack and let the tractor rest on the stands.
- DO NOT go under a tractor supported by a chain hoist or jack.

Compressed Air

- The pressure from a compressed air line is often as high as 7 bar (100 lbs/in^2). Any misuse may cause injury.
- Never use compressed air to blow dust, filings, dirt etc., away from your work area unless the correct type of nozzle is fitted and eye protection is used.
- Compressed air is not a cleaning agent, it will only move dust, etc., from one place to another. Look around before using an air hose as bystanders may get grit into their eyes, ears or skin.
- Used approved air guns, wear safety goggles, and use proper shielding to protect yourself and others in the work area.
- Never point an air nozzle at a persons body.

Hand Tools

- Many cuts, abrasions and injuries are caused by defective tools. Never use the wrong tool for the job, as this generally leads either to some injury, or to a poorly done job.
- Never use
  - A hammer with a loose head or split handle.
  - Spanners or wrenches with splayed or worn jaws.
  - Spanners or files as hammers; or drills, clevis pins or bolts as punches.
- Grind off mushroom heads from chisels. The sharp edges can tear your skin if the tool slips. And, when the tool is struck, chips could break off and fly into your eyes.
- Keep a handle on every file to prevent the tang from piercing your palm or wrist if the file should slip or catch.
- For removing or replacing hardened pins use a copper or brass drift rather than a hammer.
- For dismantling, overhauling and assembly of major components, always use Special Service Tools recommended.
- These will reduce the work effort, labour time and repair cost.
- Always keep tools clean and in good working order.

Electricity

- Electricity has become so familiar in day to day usage, that its potentially dangerous properties are often overlooked. Misuse of electrical equipment can endanger life.
- Before using any electrical equipment particularly portable appliances – make a visual check to make sure that the cable is not worn or frayed and that the plugs, sockets, etc., are intact. Make sure your know where the nearest isolating switch is located. Always use an earthed (grounded) 3 pin electrical cord.

GENERAL CONSIDERATION

Solvents

- Use only cleaning fluids and solvents that are known to be safe. Certain type of fluid can cause damage to components such as seals, etc., and cause skin irritation. Solvent label is to be checked whether chemical contained in it is harmful to the individual who uses it.

Housekeeping

- Many injuries result from tripping or slipping over or on, objects or material left lying around by a careless worker. Prevent these accidents from occurring. If you notice a hazard, don't ignore it – remove it.
- A clean, hazard-free place of work improves the surroundings and daily environment for everybody.
- Keep work organised and clean. Wipe up spills of any kind to minimise the possibility of a fall. Keep tools and parts off the floor to further reduce the possibility of tripping and causing serious injury.

Fire

- Fire has no respect for persons or property. The destruction that fire can cause is not always fully realised. Everyone must be constantly on guard.
    - Extinguish matches, cigars, cigarettes, etc., before throwing them away.
    - Keep the environment clean by disposing waste through proper container.
    - Locate the fire extinguishers and find out how to operate them.
    - DO NOT allow or use open flame near the fuel tank, fuel lines, battery, hydraulic hoses or component parts.
- When using a gas torch, always keep a fully charged fire extinguisher within reach.
- In the event of fire :
    - DO NOT panic – warn those near and raise the alarm.

First Aid

- In the type of work that mechanics are engaged in, dirt, grease, fine dust, etc. all settle upon the skin and clothing. If a cut, abrasion or burn is disregarded it may be found that an infection has formed within a short time. What appears at first to be trivial could become painful and injurious. It takes few minutes to have a fresh cut dressed, but it will take longer if you neglect it. Make sure you know where the First Aid box is located and it is kept fully stocked at all times.

OPERATIONAL CONSIDERATIONS

- Stop the engine, before performing any service.
- Place a warning sign on self propelled equipment which, due for service or overhaul, would be dangerous to start. Disconnect the battery leads if leaving such a unit unattended and remove the key.
- DO NOT attempt to start the engine while standing besides the tractor or attempt to by-pass the safety start switch. Make it a routine to check whether safety neutral switch are functioning properly.
- Avoid prolonged running of the engine in a closed building or in an area with inadequate ventilation as exhaust fumes are highly toxic
- If possible, wait for the radiator to cool before removing the cap. Place a rag over the cap to contain any released coolant and wear an insulating glove to protect your hand. Turn the cap to the first stop and wait until pressure in the system is released before removing the cap.
- Never work beneath a tractor which is on soft ground. Always take the unit to an area which has a hard level working surface (concrete is preferred) and use a mechanical jack if required.
- If it is found necessary to raise the equipment for ease of servicing or repair, make sure that safe and stable supports are installed beneath axle housing, casings, etc., before commencing work.
- Certain repair or overhaul procedures may necessitate 'Separating the tractor' either at the engine / gearbox / rear axle locations. These operations are simplified by the use of the Tractor Splitting Kit / stands. Should this equipment not be available, then every consideration must be given to stability, balance and weight of the components, especially if a cab is installed.
- Use footsteps or working platforms when servicing those areas that are not within easy reach.
- Cleanliness of the tractor hydraulic system is essential for optimum performance. When carrying

out service and repairs plug all hose ends and component connections to prevent dirt entry.

- Clean the exterior of all components before carrying out any form of repair. Dirt and abrasive dust can reduce the efficiency and working life of a component and lead to costly replacement. Use of high pressure water or steam cleaner is recommended.
- Before loosening any hoses or tubes connecting implements to remote control valves, etc., switch off the engine, remove all pressure in the lines by operating levers several times.
- Prior to pressure testing, make sure all hoses and connectors not only of the equipment, but also those of the test equipment, are in good condition and tightly sealed. Pressure readings must be taken with the gauges specified. The correct procedure should be rigidly observed to prevent damage to the system or equipment, and to eliminate the possibility to reduce the risk.
- Hydraulic fluid escaping under pressure can have enough force to penetrate the human skin. To locate a leak under pressure, use a small piece of cardboard, never use your hands. If you are injected with hydraulic fluid seek medical help immediately.
- When equipment or implements are required to be attached to the hydraulic linkage, either for testing purposes or for transportation, the 'Position Control' should be used.
- Always lower equipment to the ground when leaving the tractor.
- If high lift attachments are installed on a tractor beware of overhead power, electric or telephone cables when travelling. Drop the attachment near to ground level to increase stability and minimise risks.
- DO NOT park or attempt to service the equipment on an incline. If unavoidable, take extra care and chock all wheels.
- Prior to removing wheels and tires from a tractor, check to determine whether additional ballast (liquid or weights) has been added Seek assistance and use suitable equipment to support the weight of the wheel assembly. Store the wheel so that they cannot fall over and cause injury.
- When inflating tires beware of over inflation – constantly check the pressure. Over inflation can cause tires to burst and result in personal injury.

SERVICING TECHNIQUES

Service Safety

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all farm machinery as well as the personal safety of the individual doing the work.

This Service Manual provides general directions for accomplishing service and repair work with tested, effective techniques. Following them will help assure that a thorough repair is successfully completed.

There are numerous variations in procedures, techniques, tools, and parts for servicing tractors, as well as in the skill of the individual doing the work. This Manual cannot possibly anticipate all such variations and provide advice or cautions as to each. Anyone who departs from the instructions provided in this Manual must realise that one compromises their personal safety and the tractor's integrity by the choice of repair methods, tools and / or parts.

Service Techniques

Clean the exterior of all components before carrying any form of repair. Dirt and abrasive dust can reduce the efficient working life of a component and lead to costly replacement.

Time spent on the preparation and cleanliness of working surfaces will pay dividends in making the job easier and safer and will result in overhauled components being more reliable and efficient in operation.

Use cleaning fluids which are known to be safe. Certain types of fluid can cause damage to 'O' rings and cause skin irritation. Check the label on solvents to ensure that they are suitable for the cleaning of components and also that they DO NOT risk the personal safety of the user.

Replace 'O' rings, seals or gaskets whenever they are disturbed. Never mix new and old seals or 'O' rings, regardless of condition. Always lubricate new seals and 'O' rings with hydraulic oil before installation.

When replacing component parts use the correct tool for the job.

Hoses and Tubes

Always replace hoses and tubes if their ends are damaged.

When installing a new hose, loosely connect each end and make sure the hose takes up the designed position before tightening the connection. Clamps should be tightened sufficiently to hold the hose without crushing and to prevent chafing or contact with other parts.

Before removing hoses or tubes make sure they are identified so that they can be correctly re-assembled.

Be sure any hose which has been installed is not kinked or twisted after it is tightened.

Bearings

Bearings which are considered suitable for further service should be cleaned in a suitable solvent and immersed in clean lubricating oil until required.

DO NOT spin bearing with compressed air the centrifugal force could cause a ball or roller to fly outward with enough force to cause an injury.

Installation of a bearing can be classified in two ways. Press fit on rotating parts such as shafts & gears. Push fit into static locations such as reduction gear housings. Where ever possible, install the bearing onto the rotating component first.

Always use pullers or a press to remove and / or install bearings, bushings and cylinder sleeves, etc. Use hammers, punches and chisels only when absolutely necessary and be sure to wear safety goggles.

Shims

When shims are removed, tie them together and identify them as to location. Keep shims clean and flat until they are re-installed.

Gaskets

Be sure the holes in the gasket correspond with the lubricant passages in the mating parts. If gaskets are to be made, select material of the proper type and thickness. Be sure to cut holes in the right places. Blank gaskets can cause serious damage – always renew gaskets prior to re-installation.

Lip Type Seals

Lubricate the lips of the lip-type seals before installation. Use petroleum jelly. DO NOT use grease. Ensure that the oil seal is fitted the right way round, the lip of the seal is placed next to the lubricant that is sealed. Some seals have a second auxiliary lip, which is used to prevent the ingress of dirt to the seal lip.

During Installation, if the seal lip must pass over a shaft that has splines, a keyway, rough surface or a sharp edge, the lip can be easily damaged. Always use a seal protector, when one is provided.

Use of Bolts in Blind Holes

Use bolts of the correct length. A bolt which is too long may ‘bottom’ before the head is tight against the part it is to hold. The threads can be damaged when a ‘long’ bolt is removed. If a bolt is too short, there may not be enough threads engaged to hold the part securely.

Locking Devices

Lockwashers, flat metal locks or split pins are used to lock nuts and bolts.

Flat metal locks must be installed properly to be effective. Bend one end of the lock around the edge of the part. Bend the other end against one flat surface of the nut or bolt head. Always install new locks.

Always fit new split pins / cotter pins and bend the ends round so that they will not catch in clothing and help to prevent cuts.

Cables and Wires

When removing or disconnecting a group of cables or wires, tag each one to assure proper re-assembly.

Always clip back wires and cable looms properly to prevent chafing, cable damage and possible damage by fire.

SECTION 2

Miscellaneous Data

SECTION 2

Miscellaneous Data

Operation NO	Description	Page No
2.1	Bolt Torque Specification for inch	2A - 3
2.2	Bolt Torque Specification for MM	2A - 4
2.3	Conversion tables	2A - 5

2.1 BOLT TORQUE SPECIFICATIONS (GENERAL GUIDE FOR INCH FASTENERS)

Use the “Standard Torque” charts as a general guide when tightening fasteners that DO NOT HAVE SPECIFIC TIGHTENING RECOMMENDATIONS.

Inch Fastners Standard torque in Newton Metres (Foot pounds)					
*Inch bolt size	SAE grade 5 ** mild steel below grade 5	SAE grade 8 ISO grade 8.8 BS grade S		ISO grade 10.9 BS grade V	
		*** Non-rigid joint	**** Rigid joint	*** Non-rigid joint	**** Rigid joint
1/4 inch	6 - 8 (4 - 6)	9 - 12 (7 - 9)	11 - 15 (8 - 11)	13 - 18 (10 - 13)	16 - 22 (12 - 16)
5/16 inch	12 - 16 (9 - 12)	18 - 24 (13 - 18)	22 - 30 (16 - 22)	25 - 34 (18 - 25)	31 - 43 (23 - 32)
3/8 inch	22 - 30 (16 - 22)	31 - 42 (23 - 31)	39 - 53 (29 - 39)	44 - 60 (32 - 44)	55 - 75 (41 - 55)
7/16 inch	35 - 47 (26 - 35)	51 - 69 (38 - 51)	64 - 86 (47 - 63)	72 - 96 (53 - 71)	90 - 120 (66 - 89)
1/2 inch	54 - 72 (40 - 53)	80 - 104 (59 -77)	100 - 130 (74 - 96)	110 - 140 (81 - 103)	140 - 180 (103 - 133)
5/8 inch	110 - 140 (81 - 103)	160 - 210 (118 - 155)	200 - 260 (148 - 192)	220 - 300 (162 - 221)	280 - 370 (207 - 273)
3/4 inch	190 - 250 (140 - 184)	280 - 370 (207 - 273)	350 - 460 (258 - 339)	390 - 530 (287 - 391)	490 - 660 (361 - 487)
7/8 inch	310 - 410 228 - 302	450 - 610 (332 - 450)	560 - 760 (413 - 561)	640 - 850 (472 - 672)	800 - 1060 (590 -782)
1 inch	460 - 620 (339 - 457)	670 - 900 (494 - 664)	840 - 1120 (620 - 826)	960 - 1280 (708 - 944)	1200 - 1600 (885 - 1180)

Key to table above:

* NOTE: *The size is the diameter of the shank - not the head width.*

** NOTE: *Mild steel torque values to be used for SAE Grade 5 bolts when weld nuts, or other low strength nuts are used.*

*** NOTE: *Use these values when any of the following conditions exist:*

1. Possible damage to the joined members of the assembly may occur.
2. Thick and/or highly compressible gaskets are used between members.
3. Non -flat unmachined seating surfaces for bolt head (or nut) occurs.
4. Non -flat or non -parallel joint faces are encountered.

**** NOTE: *Use these values when ALL of the following conditions exist:*

1. Damage will not occur to the joined members of the assembly.
2. It is desirable to use this higher clamping force to ensure tightness.
3. Fastener thread is not lubricated prior to assembly.

2.2 BOLT TORQUE SPECIFICATIONS (GENERAL GUIDE FOR METRIC FASTENERS)

Use the “Standard Torque” charts as a general guide when tightening fasteners that DO NOT HAVE SPECIFIC TIGHTENING RECOMMENDATIONS

Inch Fastners Standard torque in Newton Metres (Foot pounds)					
*Inch bolt size	SAE grade 5 ** mild steel below grade 5	SAE grade 8 ISO grade 8.8 BS grade S		ISO grade 10.9 BS grade V	
		*** Non-rigid joint	**** Rigid joint	*** Non-rigid joint	**** Rigid joint
M6	4 - 5 (3 - 4)	8 - 11 (6 - 8)	10 - 14 (7 - 10)	12 - 16 (9 - 12)	14 - 20 (10 -15)
M8	10 - 13 (7 - 10)	20 - 28 (15 - 21)	25 - 35 (18 - 26)	29 - 37 (21 - 27)	36 - 46 (27 - 34)
M10	19 - 25 (14 -18)	40 - 56 (30 - 41)	50 - 70 (37 - 52)	57 - 77 (42 - 57)	72 - 96 (53 -71)
M12	33 - 43 (24 - 32)	72 - 96 (53 - 71)	90 - 120 (66 - 89)	100 - 130 (74 - 96)	120 - 160 (89 - 118)
M16	84 - 110 (62 - 81)	160 - 210 (118 - 155)	200 - 260 (148 - 192)	240 - 320 (177 - 236)	300 - 400 (221 - 295)
M20	160 - 210 (118 - 115)	340 - 450 (251 - 332)	420 - 560 (310 - 413)	480 - 640 (354 - 472)	600 - 800 (443 - 590)

Key to table above:

* *NOTE: The size is the diameter of the shank - not the head width.*

** *NOTE: Mild steel torque values to be used for SAE Grade 5 bolts when weld nuts, or other low strength nuts are used.*

*** *NOTE: Use these values when any of the following conditions exist:*

1. Possible damage to the joined members of the assembly may occur.
2. Thick and/or highly compressible gaskets are used between members.
3. Non -flat unmachined seating surfaces for bolt head (or nut) occurs.
4. Non -flat or non -parallel joint faces are encountered.

**** *NOTE: Use these values when ALL of the following conditions exist:*

1. Damage will not occur to the joined members of the assembly.
2. It is desirable to use this higher clamping force to ensure tightness.
3. Fastener thread is not lubricated prior to assembly.

2.3 CONVERSION TABLES

Area	**Multiply by**
mm^2 to in^2	0.0015
in^2 to mm^2	645.16
m^2 to ft^2	10.764
ft^2 to m^2	0.0929
ha to acre	2.4711
acre to ha	0.4047

Capacity	**Multiply by**
ml to fluid oz	0.0351
fluid oz to ml	28.413
litre to gal	0.2200
gal to litre	4.5640
litre to US gal	0.2640
US gal to litre	3.7850
gal to US gal	1.2010
US gal to gal	0.8330

Length	**Multiply by**
mm to in	0.0394
in to mm	25.400
m to ft	3.2808
ft to m	0.3048
km to mile	0.6214
mile to km	1.6093
tonne to ton	0.9842
ton to tonne	1.0160

Power	**Multiply by**
ps to hp	0.9863
hp to ps	1.0139
kW to hp	1.3410
hp to kW	0.7457

Pressure	**Multiply by**
bar to lbf/in^2	14.504
lbf/in^2 to bar	0.0690

Speed	**Multiply by**
km/hr to mile/hr	0.6214
mile/hr to km/hr	1.6093

Torque	**Multiply by**
Nm to lbf ft	0.738
lbf ft to Nm	1.356

Volume	**Multiply by**
mm^3 to in^3	0.6102
in^3 to mm^3	163.87
m^3 to ft^3	35.315
ft^3 to m^3	0.0283

Weight	**Multiply by**
gram to oz	0.3530
oz to gram	28.350
kg to lb	2.2046
lb to kg	0.4536
kg to ton	0.0010
ton to kg	1016.1

Temperature
ºC to ºF 1.8 x ºC + 32
ºF to ºC (ºF - 32) ÷ 1.8

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Section 3

Tractor Identification and Specification MF2635

TRACTOR IDENTIFICATION

Each tractor is identified by a tractor serial number and an engine serial number. To ensure prompt response to ordering of service parts or repair from your dealer, always quote the tractor model, tractor serial number and engine serial number.

The tractor model number, type & serial number (chassis serial number) is stamped on the number plate fixed at the right-hand side of the steering housing - Fig. 1

Record this number for future reference.

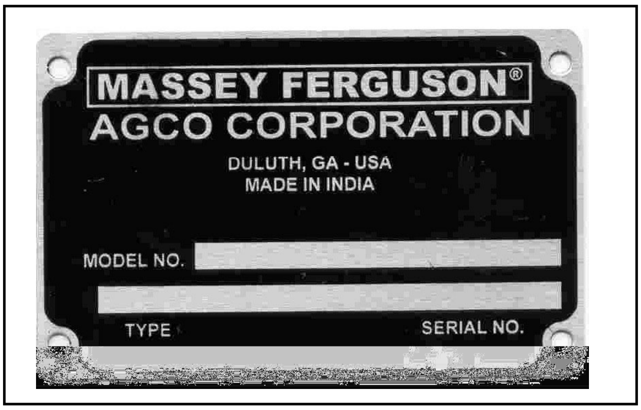
MASSEY FERGUSON®
AGCO CORPORATION
DULUTH, GA - USA
MADE IN INDIA
MODEL NO.
TYPE
SERIAL NO.

Fig. 1

The **engine serial number** is also stamped on the right-hand side of the engine block - Fig. 2.

The engine serial number for MF 2635 will be as follows:

T SJ436 E XXXXXXX

Record the exact serial number of the engine fitted to your tractor for future reference.

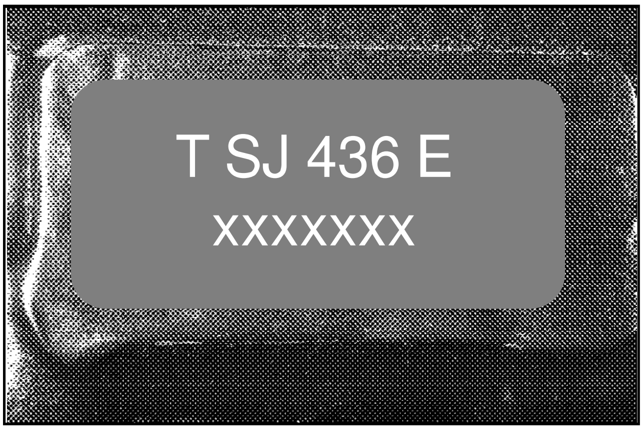
T SJ 436 E
XXXXXXX

Fig. 2

SPECIFICATION OF TRACTOR UNIT

1. ENGINE

Name of Brand with Model	...	Simpsons TSJ436E, Turbo charged, direct injection diesel with PCV (Compliance to US Tier IV Interim norms)
Country of Origin	...	India
No. of Cylinders	...	4
Fuel System	...	Direct, BOSCH rotary mechanical governor
Fuel Filters	...	Twin type (spin on) - Inline Canister type
Engine Ps (ISO14396)	...	74.8 Ps @ 2200 Erpm
On PTO	...	60 to 64 Ps @ 2200 Erpm
On independent PTO	...	58 to 62 Ps @ 2200 Erpm
Displacement	...	0.95 gal (3.6 L)
Bore	...	3.74 inch (95 mm)
Stroke	...	5 inch (127 mm)
Compression Ratio	...	18.3 : 1
Air cleaner System	...	Dry type air cleaner with primary and secondary filter element
Exhaust	...	Vertical exhaust
Engine Cooling	...	Pressurized water cooling
Throttle	...	Hand and foot throttle
Aided Start	...	5°F (–15°C)
Engine Oil Drain Period	...	250 hrs

2a. CLUTCH

Type	...	Dual dry
Diameter	...	12 inch (305 mm) & 10 inch (254 mm)
Method of Operation	...	Manual with pendant pedal type operation

2b. SPLIT TORQUE CLUTCH

Type	...	Single dry
Diameter	...	12 inch (305 mm)
Method of Operation	...	Manual with pendent pedal type operation

3a. TRANSMISSION

Transmission Type	...	Full Sliding mesh with high / low epicyclic unit
No. of Speed	...	8 Forward + 2 Reverse
Gear Shift	...	Center Shift / Side Shift

3b. TRANSMISSION

Transmission Type	...	Full Synchromesh with high / low epicyclic unit
No. of Speed	...	8 Forward + 8 Reverse

4. REAR AXLE & FINAL DRIVE

Type	...	Crown wheel and pinion (38 X 11) with differential lock and epicyclic at wheel end
Rear Track Adjustments	...	60.5 inch - 84.3 inch (1537 - 2140 mm) adjustable in steps of 4 inch (102 mm) - STD track - 60.5 inch (1537mm)

5. STEERING

Type	...	Hydrostatic, DANFOSS steering unit, Bosch hydraulic driven by engine timing case gears with separate reservior
Location	...	Above clutch housing
Diameter of Steering Wheel	...	14.8 inch (378 mm)

6a. FRONT AXLE – 2WD

Type	...	Three piece, telescopic heavy duty straight front axle.
Front Track Adjustments	...	56 inch - 72 inch (1422 - 1830 mm), adjustable in steps of 4 inch(102 mm)

6b. FRONT AXLE – 4WD

Type	...	4WD front axle
Front Track Adjustments	...	56 inch - 60.4 inch (1424 mm -1534 mm), adjustable in steps of 4 inch (102 mm)

7. BRAKES

Type	...	Oil immersed brakes, wet multiple plate disc
Method of operation	...	Manual, foot operated, individual left-hand / right-hand or combined through pendant pedal operation
Parking Brake Type & Location	...	Mechanical, hand operated, mounted on the left-hand side fender
Method of Operation	...	By hand lever on left-hand side through cables, independent of foot brakes
Size of Liners and Liner Material	...	8.81 inch (224 mm) x 0.189 inch (4.82 mm) - 8 no's with paper based non-asbestos

8. HYDRAULIC SYSTEM

Pump	...	Mark III 4 cylinder scotch yoke piston pump with suction strainer
Auxiliary Hydraulic System	...	Integral with mark III pump(MF piggyback type)
Pump Capacity	...	5.15 gpm (19.5 lpm) @ 665 PTO rpm (2200 Erpm)(basic) 10.69 gpm (40.5 lpm) @ 665 PTO rpm (2200Erpm) (auxiliary) (First pump) 5.62 gpm (21.3 lpm) @ 665 PTO rpm (2200Erpm) (auxiliary) (second pump)
Lower links	...	Cat I & II (combined ball), leveling of implement by adjustable lift rod on right-hand side
Lifting Capacity	...	2050 kgf - Horizontal Range 1850 kgf - Throughout Range

9a. POWER TAKE OFF

Method of operation	...	Manual, Engagement by hand lever located on left-hand side
PTO Speed	...	540 rpm @ 1789 Erpm
Shaft diameter	...	1 3/8 inch (34.9 mm)
No. of Splines	...	6

9b. INDEPENDENT POWER TAKE OFF

Method of operation	...	Hydraulic clutch engagement by manually, lever operated type, located on left-hand side cover
IPTO Speed	...	540 rpm @ 1789 Erpm

10. ELECTRICAL SYSTEM

(a) STARTER MOTOR

Make & Model	...	LUCAS TVS, HD 10
Type	...	Pre- engaged with protection barrier, flange mounted
Voltage	...	12 V DC
Power	...	2.8 kW
Protection	...	Can be operated only when high-low selector is in neutral position and PTO in disengaged position

(b) ALTERNATOR

Make & Model	...	LUCAS TVS, A115
Regulated Voltage	...	12 V DC
Rated Output	...	45 A

(c) LIGHTS

Head Lights	...	35 W x 4 (Halogen)
Work Lamp	...	55 W x 1 (Halogen)
Flashing warning lamp	...	21 W x 4
Turn indicator Lamp /Tail lamp	...	21/5 W x 2

(d) FUSES

Horn	...	5A
Head lamps	...	15A
Flashing lights	...	25A
Start	...	10A
Work lamp	...	10A
Tail lights	...	5A
Fuel lift pump	...	10A
Instrument Cluster illumination	...	10A

KSB circuit	...	5A
Primary fuse	...	80A
Glow plug	...	80A
Auxiliary power	...	25A
(e) RELAY	...	Starter, High beam, Low beam, Flashing warning lamps, Turn Indicator lamp, KSB circuit, Fuel lift Pump, Timer relay
(f) SWITCHES	...	Rotary light switch, ignition switch, indicator switch, horn switch

11. INSTRUMENT GAUGES

... Instrument cluster with electronic RPM meter, voltmeter, engine oil pressure gauge, engine coolant temp. gauge, fuel gauge and indicators for head light high beam, left and right-hand turn signal, turn trailer, high temperature, low oil pressure, air filter restriction, 4 WD on (Only for 4WD tractors), battery charge indicator, Glow indicating lamp

12a.TIRES (FOR 2WD)

Front Tire	...	7.50 X16 - 6 Ply on 5.50F X 16 Rim
Rear Tire	...	16.9 X 28 - 8 Ply on W15L X 28 Rim

12b.TIRES (FOR 4WD)

Front Tire	...	9.50 X 24 - 6 Ply on W8 X 24 Rim
Rear Tire	...	16.9 X 28 - 8 Ply on W15L X 28 Rim

12c.LOAD & INFLATION TABLE

TIRE LOAD LIMITS LBS AT VARIOUS COLD INFLATION PRESSURES										
Tire Size	**Psi**	**24**	**28**	**32**	**36**	**40**	**44**	**48**	**52**	**56**
	bar	**1.65**	**1.93**	**2.21**	**2.34**	**2.48**	**3.033**	**3.309**	**3.585**	**3.861**
7.50-16	**LBS**	990	1,100	1,200	1,320	1,390	14,806	1,570	1,650	17,108
	Kg	449.06	498.95	544.31	598.74	630.49	6715.88	712.14	748.42	7760.05

TIRE LOAD LIMITS AT VARIOUS COLD INFLATION PRESSURES											
Tire Size	**Psi**	**12**	**14**	**16**	**18**	**20**	**22**	**24**	**26**	**28**	**30**
	bar	**0.83**	**0.97**	**1.10**	**1.24**	**1.38**	**1.52**	**1.65**	**1.79**	**1.93**	**2.07**
9.5-24	**LBS**	1100	1200	1280	1390	1480(4)	1570	1650	1710	1820	1870(6)
	Kg	498.95	544.31	580.60	630.49	671.32 (4)	712.14	748.43	775.64	825.54	848.217 (6)
16.9-28	**LBS**	*2910	*3200	3420	3640(6)	3860	4080	4300(8)	4540	4680(10)	
	Kg	*1319.95	*1451.49	1551.28	1651.07 (6)	1750.86	1850.65	1950.44 (8)	2059.30	2122.81 (10)	

* Values at these inflation pressures are for determination of dual loads only.

CAUTION: LOAD MUST NEVER EXCEED CAPABILITIES AS STATED ON TIRE SIDEWALL.

Source : www.titanstore.com/pdf/LoadandInflation.pdf

13. SEAT

Type	...	Sliding seat with retractable seat belt

14. SHEET METAL

Fenders	...	Shell type

15. CAPACITIES

Fuel Tank	17.17 gal (65 litre)
Engine oil (Sump + Oil filter)	2.38 gal (9.0 litre)
Cooling System	3.93 gal (14.9 litre)
Transmission & Hydraulic System	10 gal (38 litre)
Hydrostatic Steering System	0.5 gal (1.9 litre)

Front Axle (4WD)

Axle	0.990 gal (3.75 litre) (DANA).
	1.453 gal (5.5 litre) (CARRARO).
Hub Reduction	0.105 gal (0.4 litre) both sides (Dana Axle)
	0.316 gal (1.2 litre) both sides (Carraro Axle)

16. DIMENSIONS & WEIGHT (2WD)

Overall Length (with Lower links)	138 inch (3510 mm)
Overall Width	77.6 inch (1972 mm)
Overall Height (Over Rops)	94 inch (2395 mm)
Wheel Base	80.1 inch (2035 mm)
Min Ground Clearance (under Gear box)	15.5 inch (395 mm)
Turning Circle Radius with Brakes	134 inch (3400 mm)
Turning Circle Radius without Brakes	146 inch (3700 mm)
Tractor Weight with quantities of fuel, oils and coolant as per fill up data	5357 lb (2460 kg) – Approx.

16a. DIMENSIONS & WEIGHT (4WD)

Overall Length (with Lower links)	138 inch (3510 mm)
Overall Width	77.6 inch (1972 mm)
Overall Height (Over Rops)	94 inch (2395 mm)
Wheel Base	81.3 inch (2066 mm)
Min Ground Clearance (under Gear box)	15.5 inch (395 mm)
Turning Circle Radius with Brakes	138 inch (3530 mm) (4WD Engaged)
Turning Circle Radius without Brakes	178 inch (4520 mm) (4WD Engaged)
Turning Circle Radius with Brakes	142.5 inch (3620 mm) (4WD Disengaged)
Turning Circle Radius without Brakes	168 inch (4260 mm) (4WD Disengaged)
Tractor Weight with quantities of fuel, oils and coolant as per fill up data	5798 lb (2670 kg) – Approx.

SPEED CHART FOR 8X2 GEAR BOX

(16.9 x 28 Rear Tires)

8x2	Low Gear Range (mph)					Low Gear Range (kph)				
Engine RPM	1	2	3	4	R	1	2	3	4	R
800	0.6	0.9	1.2	1.6	0.8	1.0	1.4	2.0	2.6	1.3
1000	0.8	1.1	1.5	2.1	1.0	1.2	1.8	2.5	3.3	1.7
1200	0.9	1.3	1.8	2.5	1.2	1.5	2.2	3.0	4.0	2.0
1400	1.1	1.6	2.1	2.9	1.5	1.7	2.5	3.4	4.6	2.3
1600	1.2	1.8	2.4	3.3	1.7	2.0	2.9	3.9	5.3	2.7
1800	1.4	2.0	2.8	3.7	1.9	2.2	3.2	4.4	5.9	3.0
2000	1.5	2.2	3.1	4.1	2.1	2.5	3.6	4.9	6.6	3.3
2200	1.7	2.5	3.4	4.5	2.3	2.7	4.0	5.4	7.3	3.7
8x2	High Gear Range (mph)					High Gear Range (kph)				
Engine RPM	1	2	3	4	R	1	2	3	4	R
800	2.4	3.6	4.9	6.6	3.3	3.9	5.8	7.9	10.6	5.4
1000	3.1	4.5	6.1	8.2	4.2	4.9	7.2	9.8	13.2	6.7
1200	3.7	5.4	7.3	9.8	5.0	5.9	8.6	11.8	15.8	8.0
1400	4.3	6.3	8.6	11.5	5.8	6.9	10.1	13.8	18.5	9.4
1600	4.9	7.2	9.8	13.1	6.7	7.9	11.5	15.7	21.1	10.7
1800	5.5	8.1	11.0	14.8	7.5	8.8	13.0	17.7	23.8	12.0
2000	6.1	9.0	12.2	16.4	8.3	9.8	14.4	19.7	26.4	13.4
2200	6.7	9.8	13.5	18.1	9.1	10.8	15.8	21.6	29.1	14.7

SPEED CHART FOR 8X8 GEAR BOX

(16.9 x 28 Rear Tires)

8x8	Low Gear Range (mph)								Low Gear Range (kph)							
Engine RPM	**F1**	**F2**	**F3**	**F4**	**R1**	**R2**	**R3**	**R4**	**F1**	**F2**	**F3**	**F4**	**R1**	**R2**	**R3**	**R4**
800	0.6	1.0	1.4	2.0	0.7	1.0	1.4	2.0	1.0	1.6	2.3	3.2	1.1	1.6	2.3	3.3
1000	0.8	1.2	1.8	2.5	0.8	1.2	1.8	2.5	1.3	1.9	2.8	4.0	1.3	2.0	2.9	4.1
1200	1.0	1.4	2.1	3.0	1.0	1.5	2.2	3.1	1.6	2.3	3.4	4.8	1.6	2.4	3.5	4.9
1400	1.1	1.7	2.5	3.5	1.2	1.7	2.5	3.6	1.8	2.7	3.9	5.6	1.9	2.8	4.0	5.7
1600	1.3	1.9	2.8	4.0	1.3	2.0	2.9	4.1	2.1	3.1	4.5	6.4	2.1	3.2	4.6	6.6
1800	1.4	2.2	3.2	4.5	1.5	2.2	3.2	4.6	2.3	3.5	5.1	7.2	2.4	3.6	5.2	7.4
2000	1.6	2.4	3.5	5.0	1.6	2.5	3.6	5.1	2.6	3.9	5.6	8.0	2.7	4.0	5.8	8.2
2200	1.8	2.7	3.9	5.5	1.8	2.7	3.9	5.6	2.8	4.3	6.2	8.8	2.9	4.4	6.4	9.0

8x8	High Gear Range (mph)								High Gear Range (kph)							
Engine RPM	**F1**	**F2**	**F3**	**F4**	**R1**	**R2**	**R3**	**R4**	**F1**	**F2**	**F3**	**F4**	**R1**	**R2**	**R3**	**R4**
800	2.6	4.0	5.7	8.1	2.7	4.0	5.9	8.3	4.2	6.4	9.2	13.1	4.3	6.5	9.4	13.4
1000	3.3	4.9	7.2	10.2	3.4	5.1	7.3	10.4	5.3	7.9	11.5	16.4	5.4	8.1	11.8	16.8
1200	4.0	5.9	8.6	12.2	4.0	6.1	8.8	12.5	6.4	9.5	13.8	19.6	6.5	9.8	14.2	20.1
1400	4.6	6.9	10.0	14.2	4.7	7.1	10.3	14.6	7.4	11.1	16.1	22.9	7.6	11.4	16.5	23.5
1600	5.3	7.9	11.5	16.3	5.4	8.1	11.7	16.7	8.5	12.7	18.4	26.2	8.7	13.0	18.9	26.8
1800	5.9	8.9	12.9	18.3	6.1	9.1	13.2	18.8	9.5	14.3	20.7	29.5	9.8	14.7	21.3	30.2
2000	6.6	9.9	14.3	20.3	6.7	10.1	14.7	20.8	10.6	15.9	23.0	32.7	10.9	16.3	23.6	33.5
2200	7.2	10.9	15.8	22.4	7.4	11.1	16.1	22.9	11.7	17.5	25.4	36.0	11.9	17.9	26.0	36.9

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SECTION 4

Splitting the Tractor

SPLITTING THE TRACTOR

Table of Contents

Operation No.	Description		Page No.
4A.1	Specification	… … … …	4A - 3
4A.2	Splitting the tractor between the front axle and engine	…	4A - 3
4A.3	Splitting the tractor between the engine and transmission	…	4A - 4
4A.4	Splitting the tractor between the transmission and rear transmission	…	4A - 5

4A.1 SPECIFICATION

Coupler Rear Drive end float : 0.014 to 0.1 inch (0.38 to 2.54 mm).

Torque Values

Front support Casting to Engine : 173.32 lbf. ft. (235 Nm).
Engine to Transmission Case : 50 – 57 lbf. ft. (68 – 77 Nm).
Transmission Case to Centre Housing : 70 – 80 lbf. ft. (95 – 108 Nm).

Special Tool

SER / 054 : Tractor Spliting stand

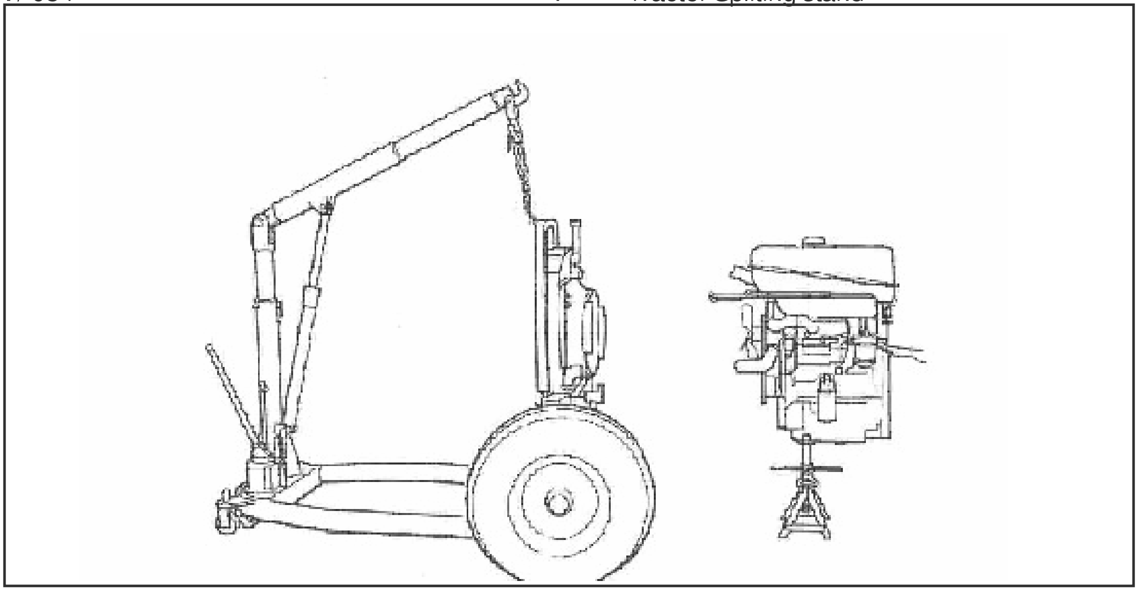

Fig 1

4A.2 SPLITTING THE TRACTOR BETWEEN THE FRONT AXLE AND ENGINE

Splitting Procedure

Dis-assembly

WARNING : Take care to keep the front axle assembly level once it has been withdrawn from the engine, otherwise it could lead to improper balance and cause injury.

1. If the tractor is four-wheel drive, first disconnect the drive shaft at the front axle end. To turn the drive shaft to gain access to the coupling split pin it may be necessary to move the tractor under power. The shaft cannot be turned without the engine running. Remove the drive shaft assembly.
2. Apply the tractor parking brake, remove the front weights (if fitted), and fit chocks to hold the rear wheels.
3. Disconnect the battery terminal.
4. Disconnect the air cleaner hoses.
5. Disconnect the head light wiring connections in grill assembly and remove the bonnet from the assembly.
6. Drain the cooling system via the drain plugs on the radiator and cylinder block.
7. Disconnect the radiator top and bottom hoses.
8. Disconnect the radiator support bar.
9. Disconnect the hydrostatic steering cylinder hoses from the cylinders.
10. Disconnect the remote greasing lines.
11. Fit hard wood wedges between the front axle casting and centre beam on both sides, to prevent the beam from pivoting.

11. Support the front axle assembly using crane and chains.
12. Support the tractor under the engine sump using suitable stand.
13. Remove front support casting securing bolts and nuts.
14. Carefully roll the two front wheels, front axle and crane forwards away from the engine.

Re-assembly

For reassembling, follow the reverse procedure above,

1. Reconnect the hydrostatic steering cylinder hoses to the steering cylinder and bleed air from the system. If necessary, top up the oil in reservoir.
2. Tighten all bolts and nuts as per the torque value.

Splitting the tractor between the engine and transmission

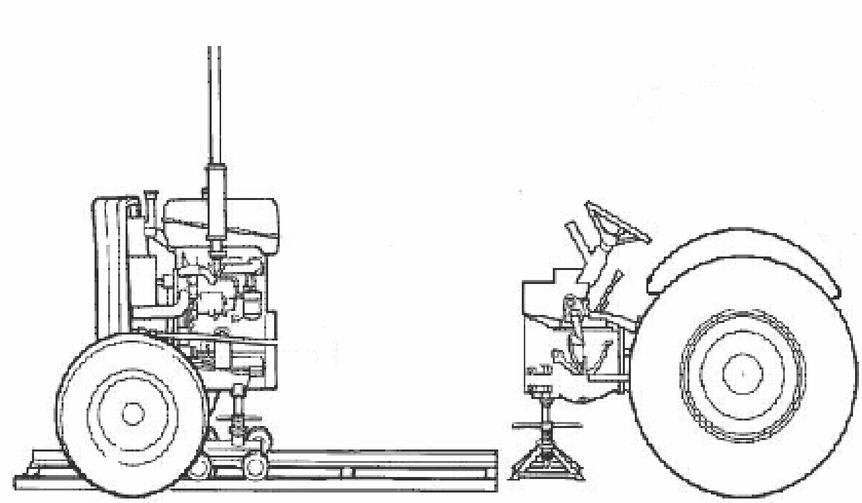

Fig 2

4A.3 SPLITTING THE TRACTOR BETWEEN THE ENGINE AND TRANSMISSION

Splitting Procedure

Special Tool

SER / 054 - Tractor spliting stand

Dis-assembly

1. If the tractor is four-wheel drive, first disconnect the drive shaft at the front axle end. To turn the drive shaft to gain access to the coupling split pin it may be necessary to move the tractor under power. The shaft cannot be turned without the engine running. Remove the drive shaft assembly
2. Apply the tractor parking brake and fit wheel chocks to hold the rear wheels.
3. Disconnect the battery terminals and remove the battery earth cable and battery.
4. Disconnect the head light wiring connections in grille assembly and remove the bonnet / hood from the tractor.
5. Disconnect the air cleaner hose.
6. Disconnect the hydrostatic steering hoses and pipe joints.
7. Close the fuel shut off
8. Fit a suitable wooden wedge between the engine cylinder head cover and fuel tank. Take care not to damage the fuel tank.
9. Disconnect the fuel tank rear support bolts.
10. Disconnect theengine fuel pump shut off control linkage.
11. Remove the two bolts securing the battery platform to the rear of the Engine.
12. Disconnect the front wiring harness.
13. Disconnect tractormeter drive cable from the rear of the engine.
14. Disconnect the throttle control linkages.
15. Loosen the Starter motor bolts and remove the starter motor with gasket.
17. Place hard wooden wedge between the Front support casting and centre beam to avoid pivoting.

16. Using the tractor spliting stand SER / 054 , support the tractor under the transmission with the fixed stand, and under the engine sump with the rails and trolley.
17. Remove all engine mounting bolts.
18. Roll the engine and front axle assembly forward with engine mounting gasket.

Re-assembly

For reassembling, follow the reverse procedure above,

1. Align the engine with the transmission case and turn the flywheel and, at the same time, roll the engine and front axle towards the transmission making sure that primary and secondary splines in main drive housing engages with the splines of primary and secondary clutch plates. Continue pushing and turning the flywheel until the engine and transmission flanges meet.

CAUTION : Do not force, fit or tighten any of the bolts until the two flanges meet,since serious damages may occur to the transmission and clutch.

2. Use new gaskets while re-assembling.
3. Refit all engine mounting bolts and tighten to a torque of 55 lbf. ft. (75 Nm)
4. For completing the rest of the tractor , follow the reverse procedure given above and
5. Reconnect the hydrostatic steering and pipe lines and bleed the air from the system and if necessary, top up the oil in reservoir.

6. Adjust the clutch play.

4A.4 SPLITTING THE TRACTOR BETWEEN THE TRANSMISSION AND REAR TRANSMISSION.

Splitting Procedure

Special Tool

SER / 054 - Tractor spliting stand

Disassembly

1. Fit wheel chocks to hold the rear wheels.
2. Drain the transmission oil via the drain plugs on the transmission case and centre housing.
3. Disconnect the battery terminals.
4. Disconnect the foot throttle linkages and then remove the step left - hand and right - hand step assemblies.
5. Disconnect the brake rods.

Splitting the tractor in between transmission and centre housing

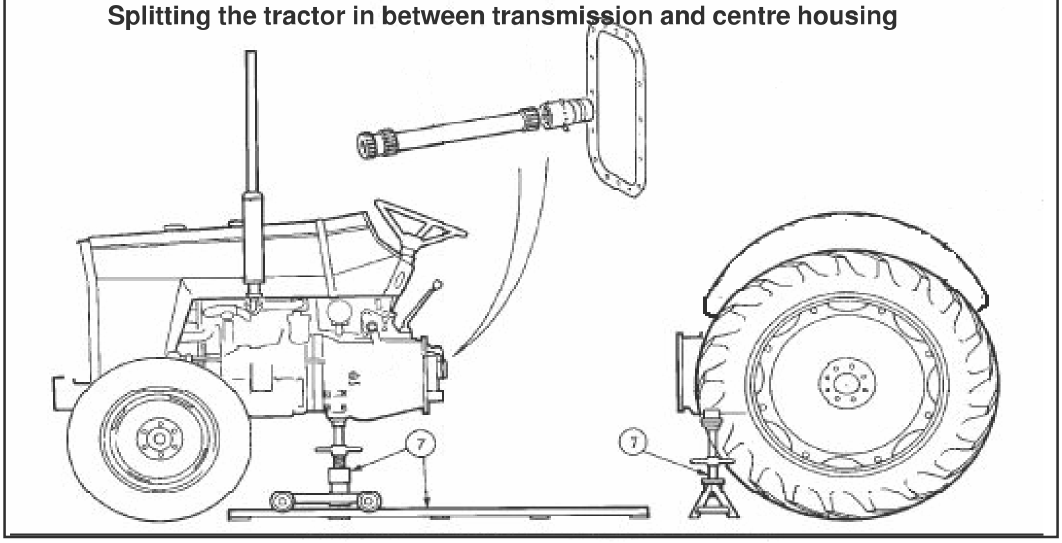

Fig 3

6. Disconnect the rear harness connections.
7. Using the SER / 054 tractor spliting stand, support the tractor under the transmission with the trolley on rails and with fixed stand under the centre housing.

8. Remove all bolts connecting the transmission and centre housing and remove the drive shaft.
9. Roll the engine and transmission assembly forward.
10. If necessary remove therear drive shaft and shaer / fuse coupler.
11. Discard the gasket between the transmission case and centre housing.

Re-assembly

For reassembling, follow the reverse procedure given above, and

1. Clean both flanges of the transmission and centre housing to remove traces of oil / grease.
2. Use new gaskets while re-assembling.
3. Take carethat the rear drive shaft and shaer coupler are correctly located and installed.
4. Ensure that the Hydraulic pump coupling is located properly.
5. Fit two guide pins approximately 100 mm long into the top, left and right sides of the centre housing flange
6. Fit the shear coupler on to the pinion with the holes around the tube towards the front.
7. Roll the engine and transmission assembly into engagement with the centre housing, ensuring alignment of the shear coupler splines onto the rear pinion splines and hydraulic pump coupling splines onto the transmission front PTO drive shaft.

   Note : *If necessary, remove the side cover for easy alignment of shear coupler with pinion.*

8. Using a suitable lever, turn the flywheel and align the transmission with the corresponding holes in the centre housing. Continue turning until the two flanges meet.

   CAUTION : Do not force, fit or tighten any of the bolts until the two flanges meet, since serious damages may occur to the transmission and PTO.

9. Refit all mounting bolts and tighten to a torque of 83 lbs. ft. (112 Nm)
10. Refill the transmission oil to the required level.
11. Re-connect the brake rods and adjust the brake.

Section 5

5. SHEET METAL

SECTION 5

SHEET METAL

Table of Contents

Operation No	Description	Page No
5.1	General description and specification	5A - 3
5.2	Hood removal and refitment	5A - 4
5.3	Air cleaner removal and refitment	5A - 5
5.4	Air cleaner overhauling	5A - 5
5.5	Head light mounting bracket removal and refitment	5A - 8
5.6	Front grill removal and refitment	5A - 8
5.7	Hinge mounting bracket removal and refitment	5A - 9
5.8	Lip seal removal and refitment	5A - 9
5.9	Gas strut removal and refitment	5A - 9
5.10	Radiator seal removal and refitment	5A - 10
5.11	Lock plate removal and refitment	5A - 10
5.12	Battery tray removal and refitment	5A - 11
5.13	Instrument panel cover removal and refitment	5A - 11
5.14	Binnacle assembly removal and refitment	5A - 12
5.15	Fender and ROPS removal and refitment	5A - 13
5.16	Footstep removal and refitment	5A - 14
5.17	Fuel tank removal and refitment	5A - 15
5.18	Seat adjustment	5A - 15

5.1GENERAL

The hood,binnacle, footsteps and fenders are all made of sheet metal. They provide protection for the operator. The tractor must not be operated with any of these sheet metal components removed.

To prevent corrosion, always keep the sheet metal components clean and immediately touch-up with paint if any painted surfaces become chipped.

Bolt Torques:

Hinge mounting bolts	...	39 lbf.ft (52 Nm).
Fender mounting bolts	...	125 lbf.ft (169 Nm).

5.2 HOOD

Removal and Refitment

Removal

1. Pull the hood latch cable and lift the hood.
2. Disconnect the battery terminals.
3. Remove the head light wiring connections on both left and right hand side of head light.
4. Support the hood with suitable wooden piece at suitable place.
5. Remove the instrument panel cover refer operation 5.13.
6. Remove the gas strut ball joint at bottom point.
7. Remove the hinge mounting bolts on both left and right hand side.
8. Lift the front edge and pull forward to clear the seal to remove the hood.

CAUTION:While removing the gas strut , the hood should be in fully opened condition, otherwise it may create an injury to the operator. Handle the hood carefully and place in scratch free area.

Refitment

9. Reverse procedures 1 to 8, except:
   a. Ensure that the rear edge of the hood is located beneath the lip of the seal.
   b. Tighten the hinge mounting bolts to a torque of 52 lbf ft (39Nm).

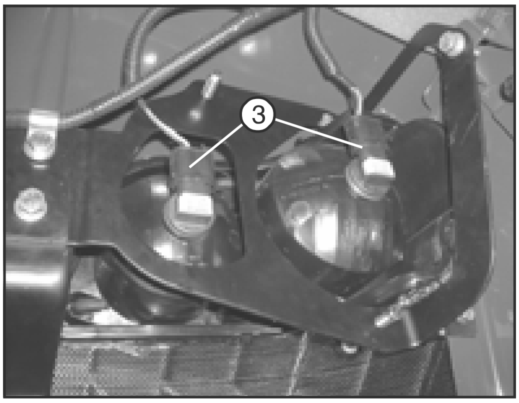

Fig 1

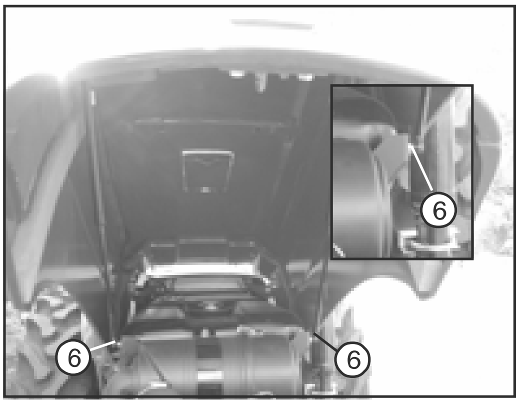

Fig 2

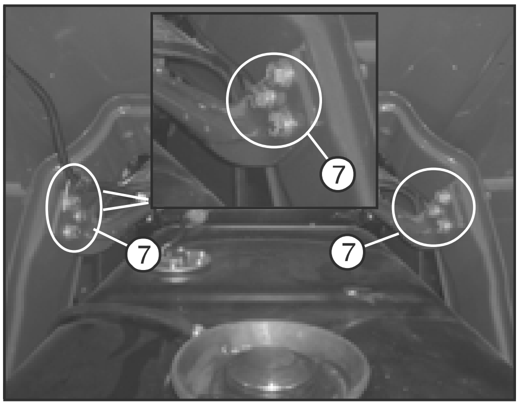

Fig 3

5.3 AIR CLEANER

Removal and Refitment

Removal

1. Pull the hood latch cable and lift the hood.
2. Disconnect the battery terminals.
3. Remove hose clamps and disconnect the hoses from air cleaner.
4. Remove the vaccum switch wiring connections.
5. Remove two bolts and spring washers securing the air cleaner and remove it.

Refitment

6. Reverse procedures 1 to 5.

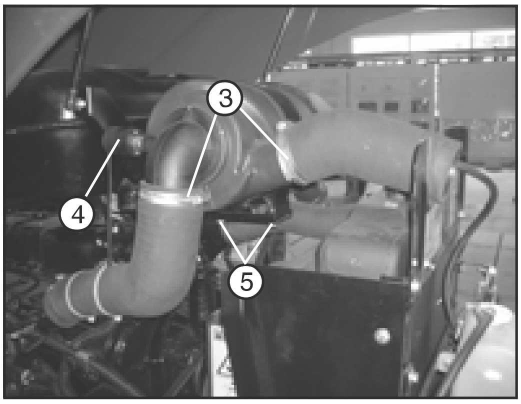

Fig 4

5.4 DRY TYPE AIR CLEANER OVER HAULING

Removal and Refitment

Removal of filter:

1. Unfasten or unlatch the service cover . Because of the filter fits tightly over the outlet tube to create the critical seal there will be some initial resistance similar to breaking the seal on a jar.
2. Gently move the end of the filter back and forth to break the seal. Avoid knocking the filter against the housing.
3. The inner secondary filter element must be replacedevery third primary filter change. Remove the inner secondary filter as you would the primary filter.
4. Make sure you cover the air cleaner outlet tube to avoid any unfiltered contaminant dropping into

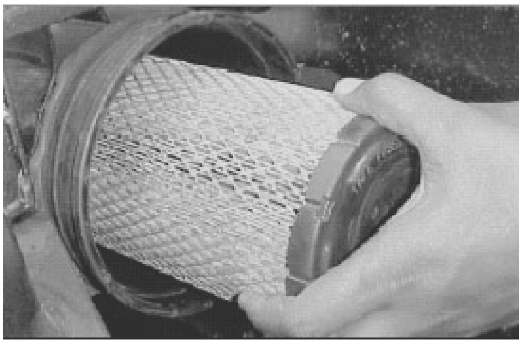

Fig 5

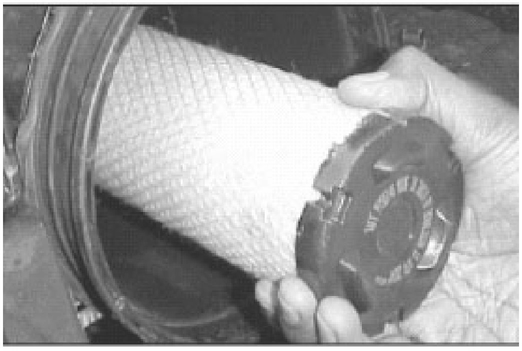

Fig 6

the engine.

Clean both surfaces of the outlet tube and empty the dust cap

1. Use a clean cloth to wipe the filter sealing surface and the inside of the outlet tube. Contaminant on the sealing surface could hinder an effective seal and cause leakage.
2. Make sure that all contaminant is removed before the new filter is inserted . Dirt accidently transferred to the inside of the outlet tube will reach the engine and cause wear .
3. Engine manufactures say that it takes only a few grams of dirt to dust an engine . Be careful not to damage the sealing area on the tube.

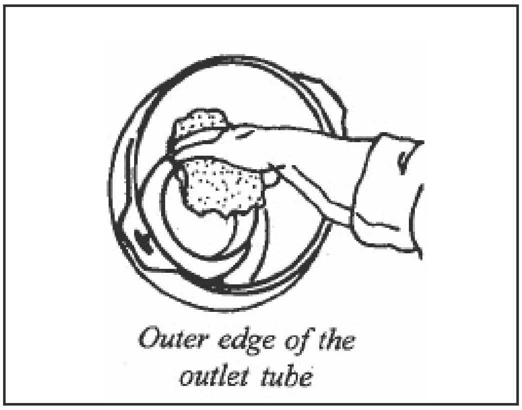

Fig 7

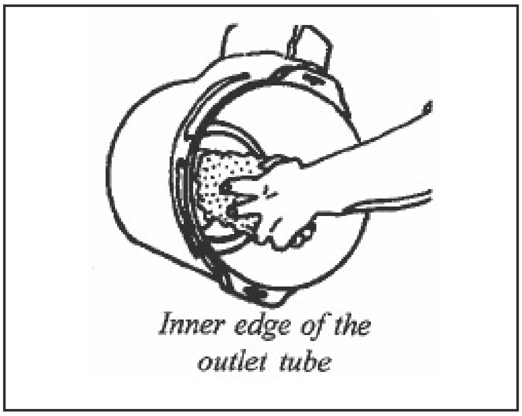

Fig 8

If your air cleaner is equipped with a dust cap

1. Empty the dust cap. Dust should not be allowed to build up closer than one inch from the baffle .
2. On models equipped with a evacuator valve, visually check and make sure the valve is not

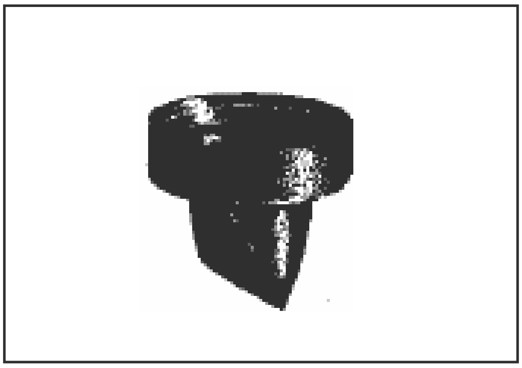

Fig 9

inverted , damaged or plugged.

Inspect the old filter for leak clues:

1. Visually inspect the old filter for any signs of leaks.A streak of dust on the clean side of the filter is a telltale sign .

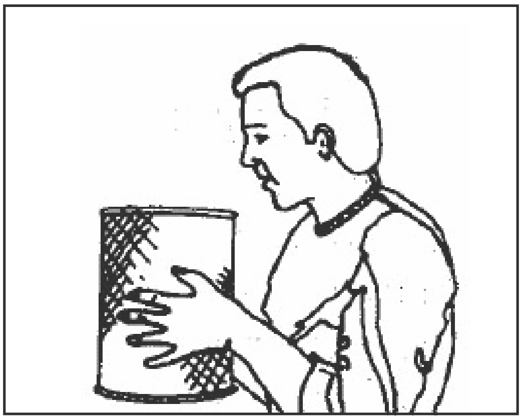

Fig 10

2. Remove any cause of leaks before installing new filter.

Inspect the new filter for damage

1. Inspect the new filter carefully , paying attention to the inside of the open end , which is the sealing area.
2. NEVER install a damaged filter . A new radial seal filter may have a dry lubricant on the seal to aid installation.

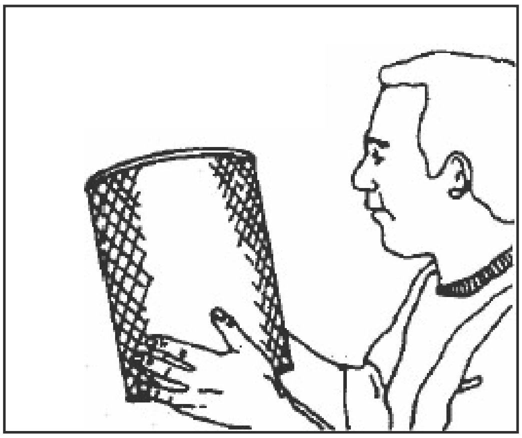

Fig 11

Insert the new radial seal filter properly.

1. If you are servicing the inner filter this should be seated into position before installing the primary filter .
2. Insert the new filter carefully .Seat the filter by hand ,making certain it is completely into the air cleaner housing before securing the cover in place.
3. The critical sealing area will strech slightly,adjust itself and distribute the sealing pressure evenly. To complete a tight seal , apply pressure by hand at the outer rim of the filter not the flexible center (Avoid pushing on the center of the urethane end cap)No cover pressure is required to hold the seal.

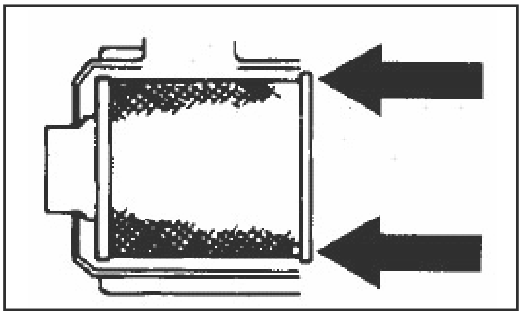

Fig 12

4. Again ,NEVER use the service cover to push the filter into place .Using the cover to push the filter in could cause damage to the housing and will void the warranty.
5. If the service cover hits the filter before it is fully in place remove the cover and push the filter (by hand) further into the air cleaner and try again. The cover should go on with no extra force.Once the filter is in place ,secure the service cover or dust cap.

Check connections for tight fit:

1. Make sure that all mounting bands ,clamps, bolts and connections in the aircleaner system are tight.Check for holes in piping and repair if needed.Any leaks in your intake piping will send dust directly to the engine.

5.5 HEAD LAMP MOUNTING BRACKET

Removal and refitment

Removal:

1. Pull the hood latch cable and lift the hood.
2. Remove hood see operation 5.2
3. Remove the vertical stiffner mounting bolts.
4. Remove the head light mounting bracket mounting bolts.
5. Remove the centre support light bracket.

Refitment:

6. Reverse the procedure 1 to 5 except

   a.Tighten all the bolts

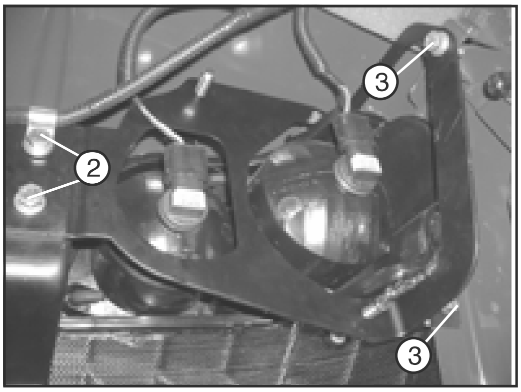

Fig 13

5.6 FRONT GRILL :

Removal and Refitment:

Removal:

1. Remove the hood see operation 5.2.
2. Remove the lock bracket with lock rod.
3. Remove the front vertical stiffner.
4. Remove the front grill mounting bolts.
5. Remove the front grill.

Refitment:

6. Reverse the procedure 1 to 5.

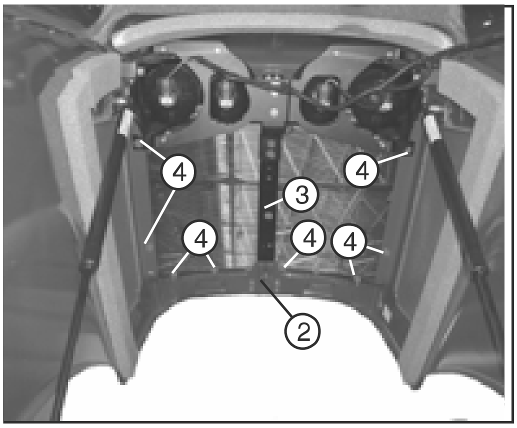

Fig 14

5.7 HINGE MOUNTING BRACKET :

Removal and refitment

Removal

1. Remove the surround and instrument cluster wiring.
2. Remove the hinge mounting bolts.
3. Remove the split pin and discard.
4. Remove the celvis pin.

Refitment:

5. Reverse the procedure 1 to 4 except.
   a. Install a new split pins.
   b. Tighten all the bolts at required torque.

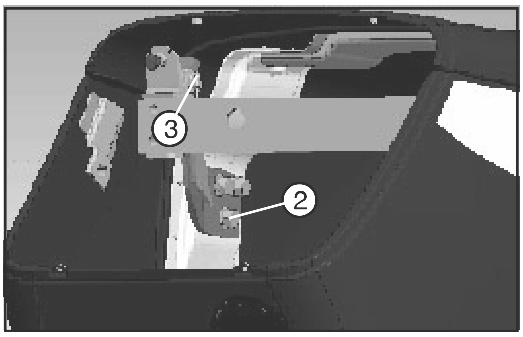

Fig 15

5.8 LIPSEAL:

Removal and refitment:

Removal:

1. Remove the hood see the operation 5.2 .
2. Remove the lip seal from the binnacle assembly and discard.

Refitment:

3. Reverse the procedure 1 to 2 except.
   a. Install a new lipseal and apply a recommended adhesive material on binnacle assembly.

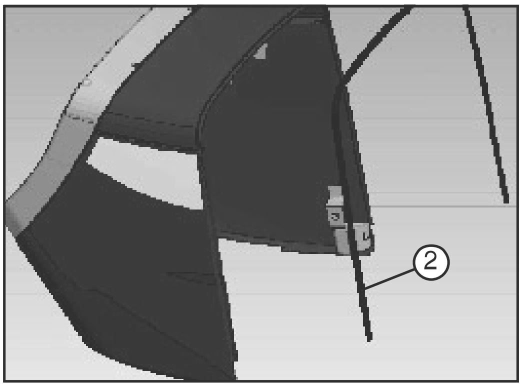

Fig 16

5.9 GAS STRUT :

Removal and refitment:

Removal:

1. Pull the hood latch cable and lift the hood fully.
2. Support the hood with wooden piece at suitable place .
3. Remove the ball joint stud at both the ends on left-hand and right-hand side.
4. Remove the gas strut .
   EXAMINE: Check the condition of gas strut , If you find any damage in gas strut , replace with new one.

Refitment:

5. Reverse the procedure 1 to 4 except.
   a. Tighten the ball joint end at required torque.

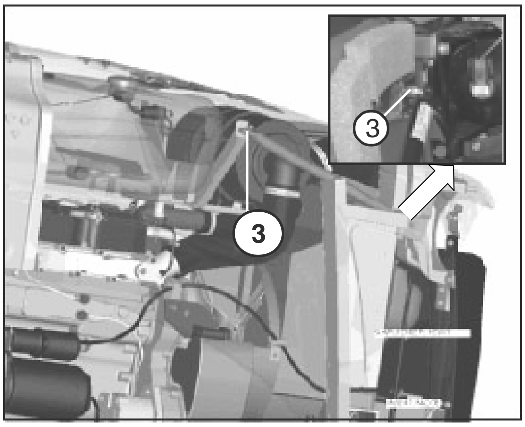

Fig 17

5.10 RADIATOR SEAL :

Removal and refitment:

Removal:

1. Pull the hood latch cable and lift the hood.
2. Strip off the seal from hood on both left-hand and right-hand side.

Refitment:

3. Reverse the procedure 1 to 2 except
   a. Install a new radiator seal and apply a recommended adhesive material.

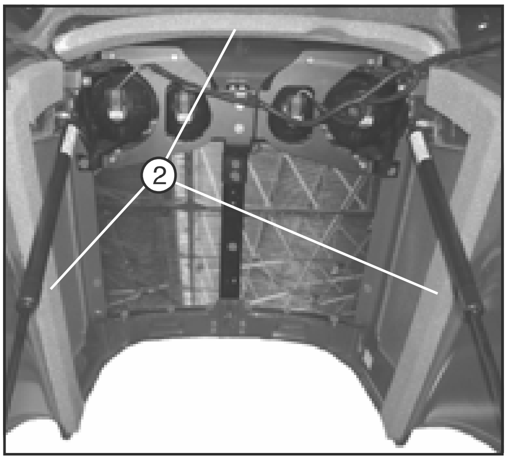

Fig 18

5.11 LOCK PLATE :

Removal and refitment:

Removal:

1. Pull the hood latch cable and lift the hood.
2. Remove the lock plate bolts .
3. Remove the lock plate from hood assembly.

Refitment:

4. Reverse the procedure 1 to 3 except.
   a. Check the condition of lock plate , if you find any wear / damage ,replace with new one.
   b. Tighten all the bolts at required torque .

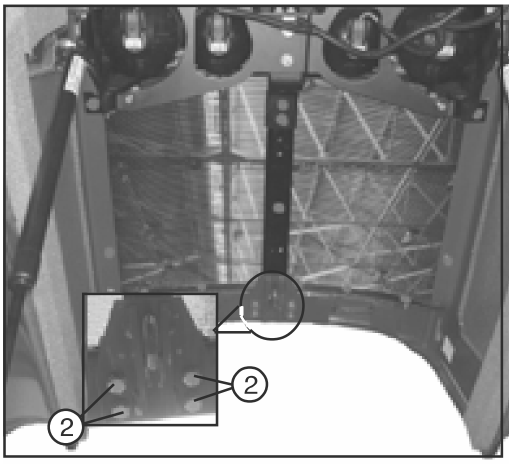

Fig 19

5.12 BATTERY TRAY

Removal and Refitment

Removal

1. Pull the hood latch cable and lift the hood.
2. Remove the battery terminals.
3. Remove the battery refer operation 14 A - 10.
4. Drain the radiator coolant from the radiator and engine.
5. Remove the shroud guard from the radiator.
6. Remove the stay rod and hoses from the radiator.
7. Remove the radiator mounting bolts and lift the radiator from the battery tray.
8. Remove the battery flat form bolts on both left and right hand side.
9. Lift the battery tray from the tractor.

Refitment

10. Reverse procedure 1 to 9.

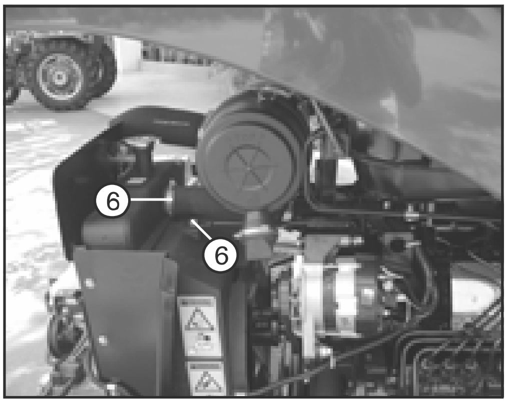

Fig 20

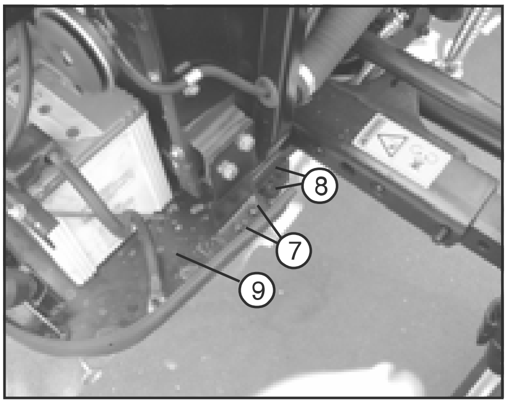

Fig 21

5.13 INSTRUMENT PANEL COVER

Removal and Refitment

Removal

1. Pull the hood latch cable and lift the hood.
2. Remove the battery terminals.
3. Remove the four bolts present in top and bottom surround.
4. Remove the bottom surround.
5. Remove the top surround along with the instrument cluster from the binnacle assembly.
6. Disconnect the wiring connections from the instrument cluster , light switch , indicator switch

Refitment

7. Reverse procedures 1 to 6, except:
   a. Ensure that the panel cover trim moulding are in good condition.

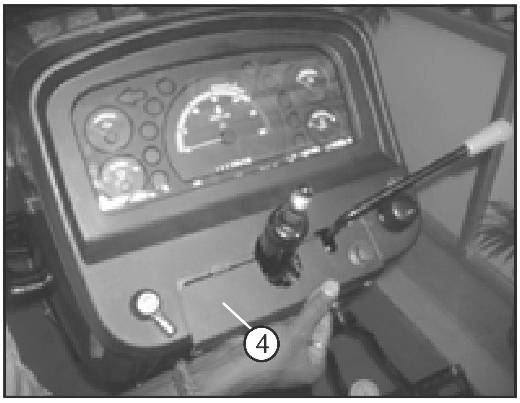

Fig 22

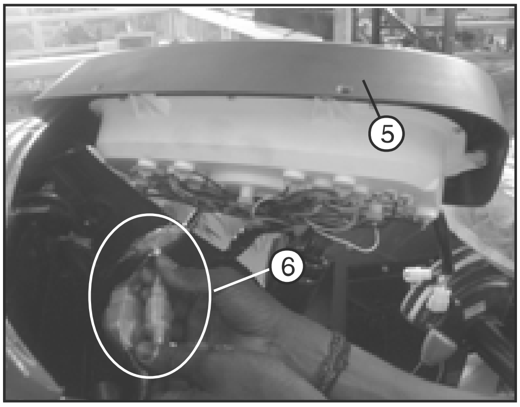

Fig 23

5.14 BINNACLE ASSEMBLY

Removal and Refitment

Removal

1. Remove the hood refer operation 5.2.
2. Remove the battery terminals.
3. Remove the bottom and top surround piece refer operation 5.13
4. Disconnect the block connectors connecting the instrument panel wiring loom from the front and rear wiring looms.
5. Remove the steering wheel.
6. Remove the four bolts retaining the assembly rear mounting bracket as well as in top mounting bracket.
7. Lift the binnacle assembly.

Refitment

8. Reverse procedures 1 to 7,

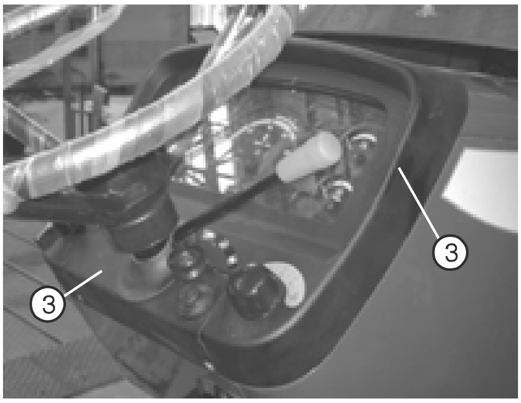

Fig 24

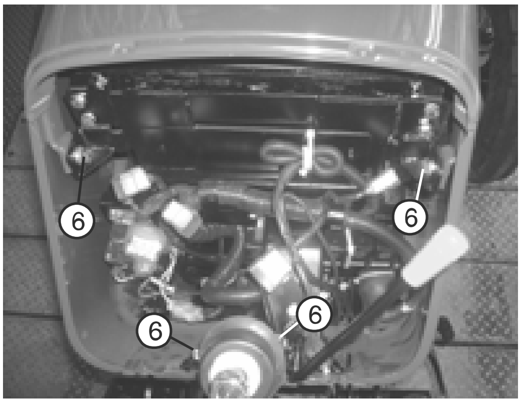

Fig 25

5.15 FENDER and ROPS

Removal and Refitment

Removal

1. Disconnect the battery terminal .
2. Disconnect the rear wiring harness at the socket, situated on rear of each foot step.
3. Remove the nuts, bolts, and washers retaining the fender extension to the foot step.
4. Remove the nuts, bolts and washers retaining the fender extension to the fender, and remove the extension.
5. Remove the hand brake mounting bracket by removing the bolts and nuts.
6. Remove the lynch pin from the stablizer chain.
7. Unscrew the two sets of lock nuts and unscrew from the fender which is placed over the ROPS.
8. Protecting the paintwork with suitable soft material, take the weight off the fender with a hoist/crane and slings.
9. Remove the fender and ROPS.
10. Unscrew the other two bolts on the ROPS to remove the ROPS from fender.

Refitment

11. Reverse procedures 1 to 10 and tighten the two nuts to a torque of 125 lbf ft (169 Nm).

    NOTE: *Incase of MF 2605 unscrew the 'U' - bolt mounted in the axle housing to remove the fender.*

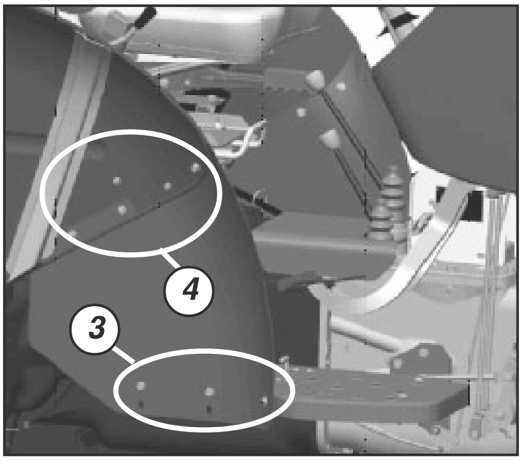

Fig 26

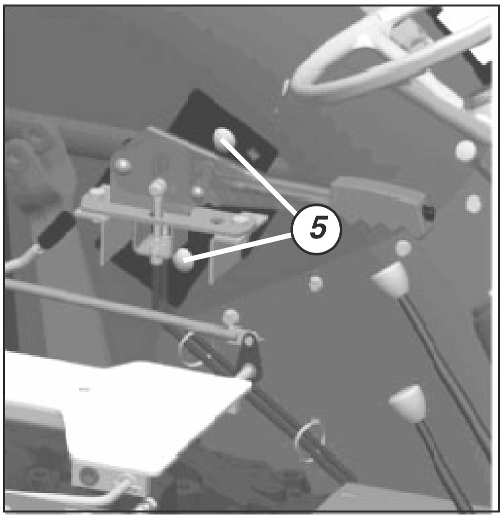

Fig 27

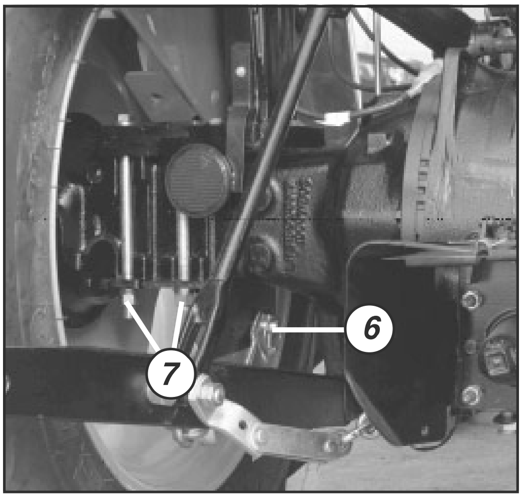

Fig 28

5.16 FOOTSTEP

Removal and Refitment

Removal

1. Remove the side nuts, washers and bolts to detach the fender from the foot step.
2. Remove the nuts, washers and carriage bolts to detach the footstep from the brackets three for (MF 2615) and two for (MF 2605) .
3. Manoeuvre the footstep from between the centre housing and fender.
4. Remove the nuts and bolts to remove the step.

   NOTE: *For removing the right hand foot step remove the foot throttle linkage pin.(refer 'A' in fig* ***29****)*

Refitment

5. Reverse procedures 1 to 4.

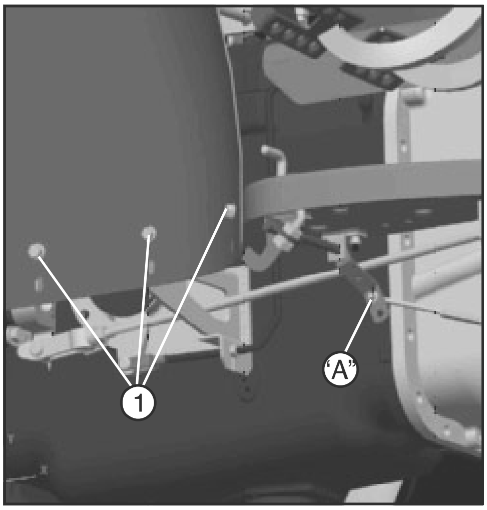

Fig 29

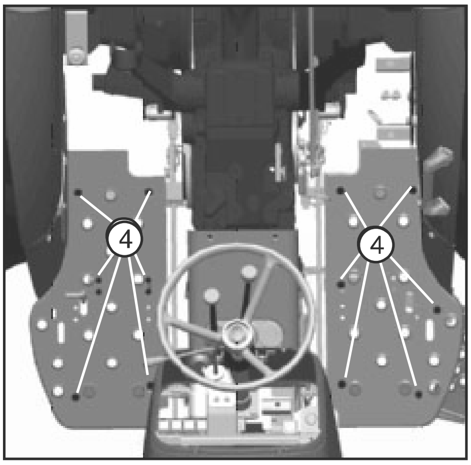

Fig 30 for MF 2615

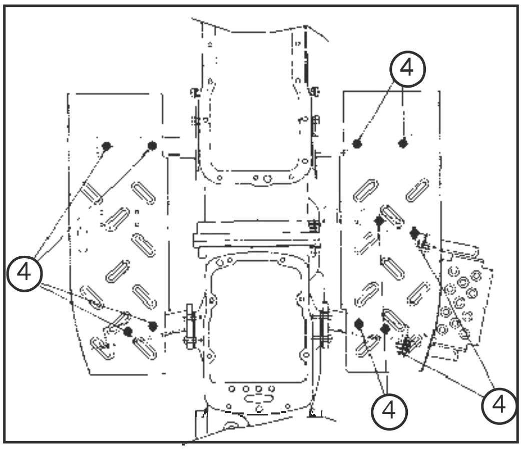

Fig31 for MF 2605

5.17 FUEL TANK:

Removal and refitment of fuel tank:

Removal

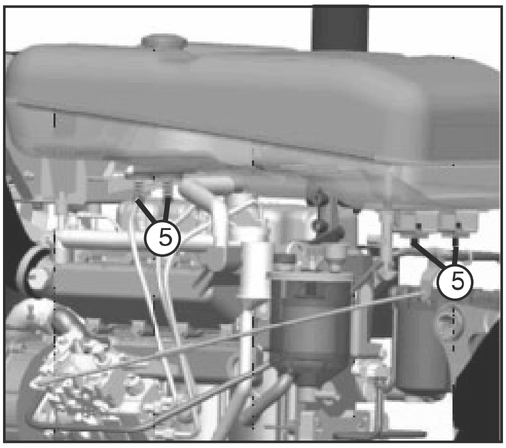

Fig 32

1. Remove the hood see the operation 5.2
2. Disconnect the fuel sensor terminals.
3. Drain the fuel from the tank by lengthening the fuel hose at the fuel feed pump.
4. Turn off the fuel and remove the fuel gauge float by removing the six screws securing the fuel gauge float.
5. Remove the fuel pipe lines which is connected to fuel tank.
6. Remove the four bolts securing the fuel tank assembly.

Examine: Check for any damage in fuel tank , which leads to leakage

Refitment:

6. Reverse the procedure 1 to 5 except .
   a.Clean the fuel tank.

5.18 SEAT ADJUSTMENT

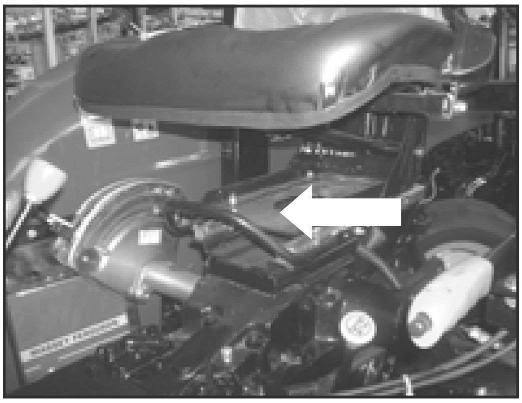

Fig 33

For comfortable operation of various controls, the seat can be adjusted to suit most operators height and weight. Slots provided at the bottom of the seat mounting bracket permits backward and forward movement of seat and also it can be adjusted using the lever provided. The slots provided at the back rest facilitate to raise and lower it. The seat has a spring suspension fitted with shock absorbers which can be customized for maximum comfort. The adjustment knob at the back of the seat stiffens seat movement when turned clockwise and softens when turned counterclockwise.

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SECTION 6

PART A

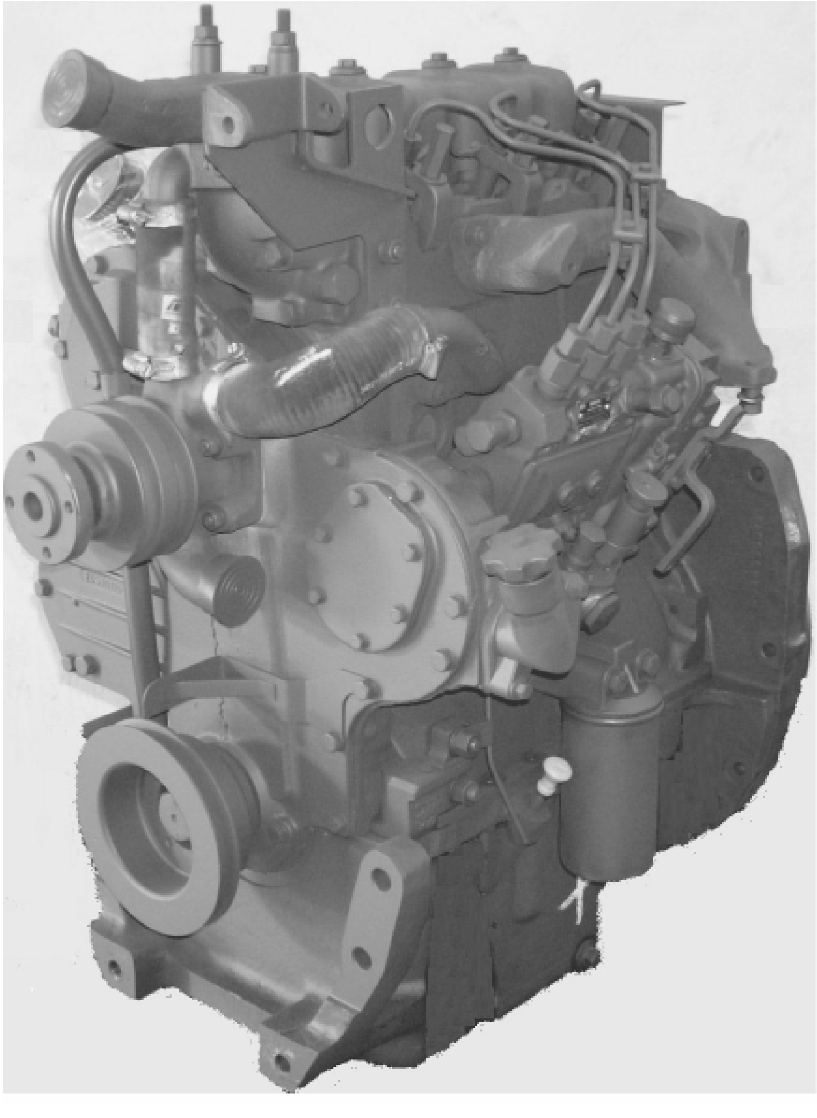
ENGINE S325.3

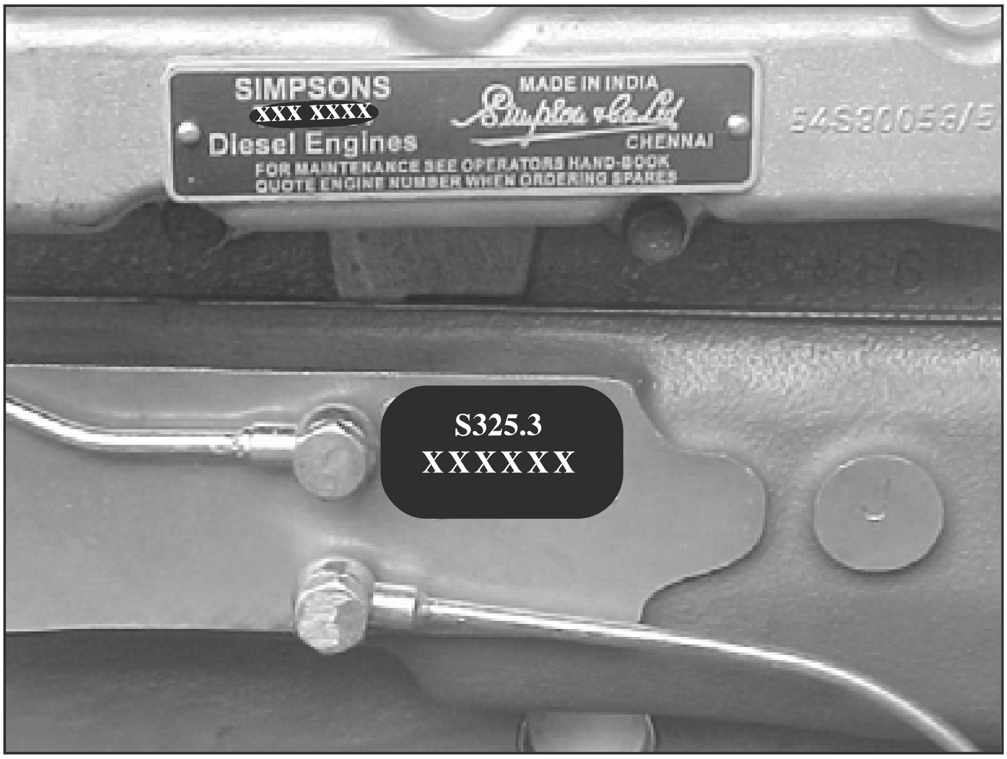
CONTENTS

Section	Description		Page No.
A	ENGINE VIEW	...	6A -3
	ENGINE NUMBER LOCATION	...	6A - 4
	EPA STICKER LOCATION	...	6A - 5
B	THREADS / RECOMMENDED TORQUE	...	6A - 6
	TECHNICAL DATA	...	6A - 7
	MANUFACTURING DATA AND DIMENSIONS	...	6A - 8
C	OPERATING AND MAINTENANCE	...	6A - 16
D	FAULT FINDING CHART	...	6A - 21
E	CYLINDER HEAD	...	6A - 32
F	PISTONS AND CONNECTING RODS	...	6A - 36
G	CYLINDER BLOCK AND LINERS	...	6A - 39
H	CRANKSHAFT AND MAIN BEARINGS	...	6A - 40
J	TIMING CASE AND DRIVE	...	6A - 45
K	TIMING	...	6A - 49
L	LUBRICATING SYSTEM	...	6A - 51
M	COOLING SYSTEM	...	6A - 56
N	FUEL SYSTEM AND AIR CLEANERS	...	6A - 58
O	FIP CALIBRATION CHART	...	6A - 61
P	FLY WHEEL AND FLY WHEEL HOUSING	...	6A - 63
Q	LUBRICATING OILS SPECIFICATION	...	6A - 64
Appendix - I		...	6A - 65

Section A

ENGINE VIEW




SIMPSONS
XXX XXXX
Diesel Engines
MADE IN INDIA
CHENNAI
FOR MAINTENANCE SEE OPERATORS HAND-BOOK
QUOTE ENGINE NUMBER WHEN ORDERING SPARES
S325.3
XXXXXX

ENGINE TYPE AND NUMBER LOCATION

The engine number is stamped on the camshaft tunnel of the cylinder block – on the right side of the engine.

When requesting information regarding the engine, the number should be quoted.

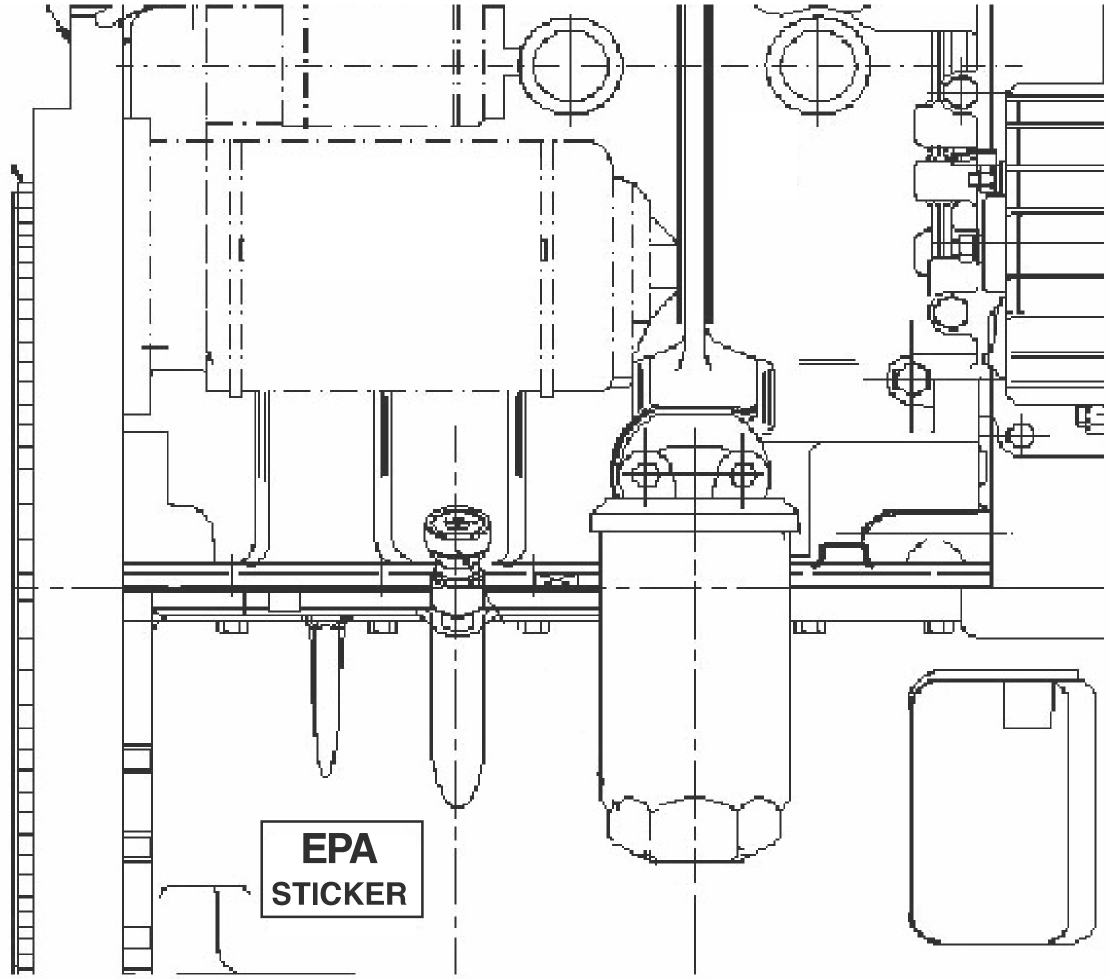
S 325.3 Engine : *Called S325 Dot Three Engine*

The suffix number “called Dot Three” indicates development of S325.2 engine with the following modified components to meet US TIER II

Alfin Piston with re-entrant bowl (3-ring pack), ‘P’ type Injector, Spill timing 14.+/- 1° BTDC.

ENVIROMENTAL PROTECTION AGENCY (EPA) LOCATION

The EPA Sticker is located on both sides of the engine oil sump



Section B

S325.3 DIESEL ENGINES

ALL THREADS USED ON S 325.3 ENGINES, ARE METRIC SERIES
EXCEPT THE COMPONENTS INDICATED BELOW

(Refer annex for modification)

1.	Stud/Nut/Setscrew, Cylinder Block to Cylinder head	...	7/16"	–	20 UNF
2.	Bolt and Nut, Connecting Rod	...	7/16"	–	20 UNF
3.	Balance Weight Setscrew	...	7/16"	–	20 UNF
4.	Bridge Piece Timing Case (Applicable for earlier type)	...	5/16"	–	24UNC
5.	Plug Cylinder Head	...	1/2"	–	14 PTF
6.	Thermostart fixing hole in the induction manifold	...	7/8"	–	14 UNF
7.	Union, Rocker oil feed in Cylinder head	...	1/8"	–	27 NPSI
8.	Oil pressure gauge connection on pressure rail	...	1/4"	–	18 NPSI

RECOMMENDED TORQUE TENSIONS

The following torque figures will apply with the components lightly oiled before assembly :

Cylinder head nut and setscrews (NRT)*	...	80	lbf. ft.	10.8	Kgf. m.	(7/16-20 UNF)
Connecting rod nuts (Cadmium plated)	...	45	lbf. ft.	6.2	Kgf. m.	(7/16-20 UNF)
Connecting rod nuts (Phosphated)	...	60	lbf. ft.	8.2	Kgf. m.	(7/16-20 UNF)
Main bearing setscrews	...	115	lbf. ft.	15.9	Kgf. m.	(M 14 x 2)
Balance weight setscrews	...	55	lbf. ft.	7.6	Kgf. m.	(7/16-20 UNF)
Idler gear retaining setscrew	...	50	lbf. ft.	6.9	Kgf. m.	(M 12 x 1.5)
Camshaft gear retaining setscrews	...	21	lbf. ft.	2.9	Kgf. m.	(M 8 x 1.25)
F.I. pump adapter to F.I. pump nut	...	45	lbf. ft	6.2	Kgf. m.	–
F.I. pump gear to adapter setscrews	...	21	lbf. ft.	2.9	Kgf. m.	(M 8 x 1.25)
Flywheel setscrew	...	80	lbf. ft.	11.1	Kgf.m.	(M 12 x 1.25)
Crankshaft pulley retaining setscrews	...	110	lbf. ft.	15.2	Kgf. m.	(M 22 x 2.5)
Atomiser securing nuts	...	12	lbf. ft.	1.7	Kgf. m.	(M 8 x 1.00)

NOTE : Cylinder head gasket used on S325.3 engines are 'Non-retorque' type. It should be fitted Dry. ***'Top Front'*** *mark should face the cylinder head. (Ref. Fig. E2 / Page 33 – For tightening sequence)*

* NRT – Non-retorque type gasket (New type now being used in all S3 engines in production)

This new type gasket does not require retorquing in predelivery inspection

Section B

Technical Data

Type	Three Cylinder, Four Stroke, Direct Injection
Aspiration	Naturally aspirated
Bore (Nominal dia)	3.6 inch (91,44 mm)
Stroke	5 inch (127 mm)
Cubic Capacity	152 inch^3 (2.5 litres)
Compression Ratio	18.5 :1
Basic Thread Form	Metric
Firing Order	1, 2, 3
Rotation	Anti-clockwise from the flywheel end
Tappet Clearance	0.012 inch (0.30 mm) Cold 0.010 inch (0.25 mm) Hot
Lubricating Oil Pressure	30/60 lbf/in^2 (2.1/4.2 kg/cm^2)
Injector Setting Pressure	235 bar (3410 psi)
Fuel Injection Pump	MICO inline type with mechanical governor, flange mounted.
Fuel Feed Pump	Integral with Fuel Injection Pump
Electrical System	12 Volts
Inlet valve opens	13° BTDC
Exhaust valve closes	10°A TDC
Total Inlet open period	236°
Total exhaust open period	236°
Injection timing (spill timing)	14+/- 1° B.T.D.C.
Air Cleaner	Dry Type Air Cleaner
Engine Ratings :	
Maximum Gross Rating kW (bhp)	28Kw (38.06 hp) @ 2000 rpm
Maximum Gross Torque NM (Kgm)	15.2 kgm (109 lbf.ft) @ 1400 rpm
Rating Standard	ISO 14396
Application	Tractor

De-Rating for Altitude

Where engines are called upon to operate in rarefied atmospheres occasioned by altitude, such engines should be de-rated.

Any necessary adjustments in this respect to the fuel pump should be carried out by the MICO dealer for the territory concerned.

Approximate Engine Weight

Basic weight (with alternator but without starter motor, flywheel housing) ... 204 Kg (450 lbs).

Typical installed weight (with starter motor, flywheel and flywheel housing) ... 290 Kg (640 lbs).

Approximate Engine Dimension

Length 22.95 inch (583 mm), Width 23.46 inch (596 mm), Height 29.33 inch (745 mm).

Manufacturing Data and Dimensions

The following data of clearances and tolerances are given as a guide for personnel engaged in major overhauls and the figures are those used in the factory for production purposes.

Cylinder Block

Height of Cylinder Block from Top and Bottom Face	13.7405/13.7435 inch (349.01/349.08 mm)
Parent Bore Dia. for Cylinder Liner	3.6875/3.6885 inch (93.66/93.69 mm)
Depth of Recess for Liner Flange (Cast Iron Liners)	0.152/0.148 inch (3.76/3.86 mm)
Dia. Recess of Liner Flange (Cast Iron Liners)	3.825/3.820 inch (97.16/97.03 mm)
Main Bearing Parent Bore Dia	2.9165/2.9175 inch (74.08/74.10 mm)
Camshaft Bore Dia. - No. 1	1.874/1.877 inch (47.60/47.68 mm)
Camshaft Bore Dia. - No. 2	1.864/1.867 inch (47.35/47.42 mm)
Camshaft Bore Dia. - No. 3	1.844/1.847 inch (46.84/46.91 mm)

Cylinder Liners - Cast Iron

Type – Production Liner	Dry- semi finished interference Fit
– Service Liner	Dry-Pre-finished-Transition Fit
Outside Dia. of Production Liner	3.6895/3.6905 inch (93.71/93.74 mm)
Outside Dia. of Service Liner	3.6875/3.6885 inch (93.66/93.69 mm)
Interference Fit of Production Liner in Block	0.001/0.003 inch (0.025/0.076 mm)
Transition Fit of Service Liner in Block	0.001/ 0.001 inch (0.025/0.025 mm) or Interference Fit of 0.001 inch
Inside Dia. of Finished Liner in Block	3.6015/3.6025 inch (91.48/91.50 mm)
Outside Dia. of Liner Flange	3.803/3.808 inch (96.60/96.72 mm)
Flange Thickness	0.148/0.150 inch (3.76/3.81 mm)
Depth of Liner Flange relative to Top Face of Cylinder Block	+0.002 to - 0.004 inch (+0.05/-0.10 mm.)

***NOTE:** Reboring to oversize is not recommended*

Piston :

Type	Alfin Piston with Re-entrant bowl. Offset of re-entrant bowl on piston crown should be towards fuel pump side while assembly. An arrow (or) ‘F’ mark is stamped on top surface of piston for identification
Piston Height in relation to Cylinder Block Top Face	0.005 - 0.002 inch (0.150 / 0.060 mm) Above block surface
Bore Dia. for Gudgeon Pin	1.2503 / 1.2501 inch (31.758 / 31.753 mm)
Top Ring Groove Width	0.118 inch (3.0 mm) – Nominal width
2nd Ring Groove Width	0.080 / 0.815 inch (2.05 / 2.03 mm)
3rd Ring Groove Width	0.159 / 0.158 inch (4.05 / 4.03 mm)

Ring Gaps

The ring gaps quoted below are for a bore diameter of 3.6015 inch (91.48 mm). When checking ring gaps in a worn bore, 0.003 inch (0.076 mm) should be added to these ring gaps for every 0.001 inch (0.025 mm) increase in bore diameter.

Piston Rings

Top Compression	Chromium inlaid, Half Keystone ('Top' marked)
2nd Compression	Cast Iron, Taper land ('Top' marked)
3rd Oil Control	Conformable oil control ring
Top Ring width	0.118 inch (3.0 mm) – Nominal
2nd Ring width	0.078 / 0.077 inch (1.99 / 1.97 mm)
3rd Ring width	0.157 / 0.156 inch (3.99 / 3.97 mm)

Ring Clearance in Piston Groove

Top ring clearance in Groove	Nil (since keystone)
2nd and 3rd ring clearance in Groove	0.00315 / 0.00157 inch (0.08 / 0.04 mm)

Ring Gaps

Ring Gap - Top	0.0216 / 0.0118 inch (0.55 / 0.30 mm)
Ring Gap - 2nd	0.0394 / 0.0315 inch (1.0 / 0.8 mm)
Ring Gap - 3rd	0.0216 / 0.0118 inch (0.55 / 0.30 mm)

NOTE: *The ring gaps given above are for when checking in the unworn portion of the cylinder bore.*

Gudgeon Pin

Type	Fully Floating
Outside Dia. of Gudgeon Pin	1.24975 / 1.250 inch (31.744 mm / 31.750 mm)
Fit in Piston Boss	Transition
Clearance Fit in Small End Bush	0.0005 / 0.0017 inch (0.0127 / 0.0441 mm)

Small End Bush

Type	Steel Backed, Lead Bronze Lined
Outside Dia.	1.3785 / 1.3800 inch (35.01 / 35.05 mm)
Length	1.04 / 1.058 inch (26.42 / 26.87 mm)
Inside Dia. after Reaming	1.2505 / 1.2515 inch (31.76 / 31.79 mm)

Connecting Rod

Type	"H" Section
Big End Parent Bore Dia.	2.3950/2.3955 inch (60.83/60.85 mm)
Small End Parent Bore Dia.	1.37478/1.37620 inch (34.92/34.96 mm)
Big End Width	1.5502/1.5525 inch (39.38/39.43 mm)
Big End Side Clearance on Crankpin	0.009 / 0.015 inch (0.236 / 0.375 mm)
Length Between Bore Centers	8.813 / 8.890 inch (223.85 / 223.82 mm)

NOTE: *The numbered side on connecting rod and cap should be on the fuel injection pump side.*

Connecting Rod Alignment

Large and small end bores must be square and parallel to each other within the limits of ± 0.010 inch (0,25 mm), measured 5 inch (127 mm) each side of the axis of the rod on test mandrel as shown in Fig. B1. With the small end bush fitted, the limit of ± 0.010 inch (0,25 mm) is reduced to ± 0.0025 inch (0,06 mm)

***NOTE :** Connecting rod nuts should be replaced whenever the big ends are disturbed.*

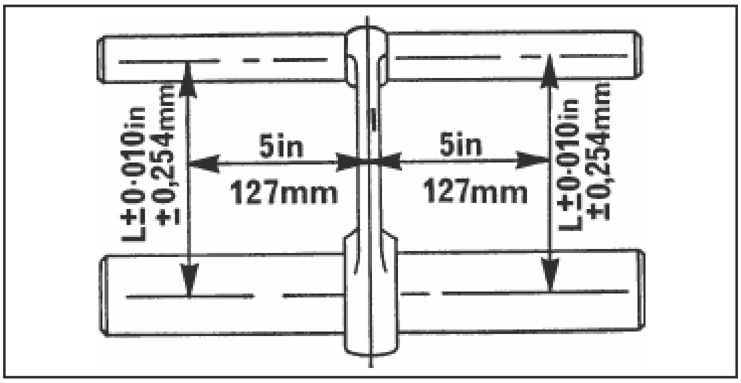


Fig. B1 Connecting Rod

Connecting Rod Bearings

Type	...	Pre-finished, Steel Backed, Aluminium Tin/Copper Lead
Inside Dia.	...	2.252/2.2525 inch (57.19/57.21 mm)
Bearing Running Clearance	...	0.0025/0.0040 inch (0.06/0.10 mm)

Crankshaft (Ref. Fig. H1)

Main Journal Dia. **(Std.)**	...	2.7485/2.7493 inch (69.81/69.83 mm)
Main Journal Length - Number 2 and 3	...	1.2147/1.2227 inch (30.85/31.06 mm)
Main Journal Length-Rear	...	1.8427/1.8457 inch (46.80/46.88 mm)
Main Journal Fillet Radii **(Except Last Main Journal)**	...	0.125/0.140 inch (3.175/3.556 mm)
Last Main Journal Fillet Radius	...	0.1562/0.1662 inch (3.97/4.22 mm)
Crankpin Dia. **(Std.)**	...	2.2484/2.2492 inch (57.11/57.13 mm)
Crankpin Length	...	1.562/1.570 inch (39.67/39.88 mm)
Crankpin Fillet Radii	...	0.172/0.155 inch (4.37/3.96mm)
Surface Finish-All Pins and Journals	...	16 micro inches (0.4 microns) Maximum
Crankshaft End Float	...	0.002/0.015 inch (0.05/0.38 mm)
Crankshaft rear end Seal	...	Lip type
Regrind Undersizes-Main Journals and Pins	...	0.010 inch (0.25 mm), 0.020 inch (0.51 mm), 0.030 inch (0,76 mm)

*NOTE : when regrinding, the crank pin length should not exceed 1.575 inch (40,00 mm) and the rear main journal (Crankshaft with lip type rear oil seal) length should not exceed 1.861 inch (47,27 mm) and Nos. 2 and 3 main Journals Width should not exceed 1.2275 inch (31,1785 mm) maximum. **The maximum permissible UNDERSIZE is 0.030 inch (0,76 mm).***

Crankshaft Thrust Washers

Type	Steel Backed, Aluminium Tin
Position in Engine	Cylinder Block, Rear Main Bearing Housing
Thrust Washer Thickness – **Standard**	0.121/0.123 inch (3.07/3.12 mm)
Thrust Washer Thickness – **Oversize**	0.1285/0.1305 inch (3.26/3.31 mm)

Main Bearings

Type	Prefinished Steel Backed, Aluminium Tin/ Copper Lead
Inside Dia. (Fitted)	2.752/2.7535 inch (69.90/69.94 mm)
Main Bearing Running Clearance	0.0027/0.005 inch (0.07/0.13 mm)

Camshaft

No. 1 Journal Dia.	1.869/1.870 inch (47.47/47.50 mm)
Running Clearance	0.004/0.008 inch (0.10/0.20 mm)
No. 2 Journal Dia.	1.859/1.860 inch (47.22/47.24 mm)
Running Clearance	0.004/0.008 inch (0.10/0.20 mm)
No. 3 Journal dia.	1.839/1.840 inch (46.71/46.74 mm)
Running Clearance	0.004/0.008 inch (0.10/0.20 mm).
Cam Lift	0.311/0.314 inch (7.90/7.98 mm)
Gear-Spigot Dia.	1.9985/1.9995 inch (50.76/50.79 mm)
Oil ways for Rocker Shaft Lubrication	No. 2 Cam Journal

Cylinder Head

Depth	2.985/3.015 inch (75.82/76.58 mm)
Leak Test Pressure	30 lbf/in^2 (2.11 kgf/cm^2)
Valve Seat Angle	36°
Tappet Bore in Cylinder Head	0.6245/0.6258 inch (15.86/15.895 mm)
Valve Guide Bore in Cylinder Head	0.4995/0.5005 inch (12.69/12.71 mm)
Permissable Cylinder Head Bow - Transverse	0.003 inch (0.076 mm) maximum
Longitudinal	0.006 inch (0.152 mm) maximum
Skimming Allowance on Head Face	0.012 inch (0.30 mm) maximum Provided nozzle protrusion does not exceed 0.184 inch (4.67 mm) after skimming
Valve layout	I, E, E, I, I, E

Valve Guides

Inside Dia.	0.3148/0.3158 inch (7.99/8.02 mm)
Outside Dia.	0.5018/0.5013 inch (12.74/12.73 mm)
Overall Length	2.2188 inch (56.36 mm)
Guide Protrusion above Spring Seating Face	0.362/0.376 inch (9.19/9.55 mm)
Interference fit of guide in head	0.0016/0.0031 inch (0.04/0.08 mm)

NOTE: *Valve stem seal (with metal insert) is fitted in both inlet and exhaust valves.*

Inlet Valve

Valve Stem Dia.	0.311/0.312 inch (7.90/7.92 mm)
Clearance Fit of Valve in Guide	0.0028/0.0048 inch (0.071/0.12 mm)
Valve Face Angle	35°
Valve Depth below Cylinder Head Face (Inlet)	0.050/0.062 inch (1.27/1.57 mm) Not to exceed 0.072 inch (1.83 mm) after regrinding

Exhaust Valve

Valve Stem Dia.	0.311/0.312 inch (7.90/7.92 mm)
Clearance Fit of Valve in Guide	0.0028/0.0048 inch (0.071/0.12 mm)
Valve Face Angle	35°
Valve Depth below Cylinder Head Face (Exhaust)	0.061/0.074 inch (1.54/1.88 mm) Not to exceed 0.083 inch (2.11 mm) after regrinding

Valve Spring

Free Length	1.783/1.803 inch (45.29/45.80 mm)
Fitted Length	1.500 inch (38.10 mm)
Load at Fitted Length	22.75 lbs ± 2lbs (10.34 kg ± 0.90 kg)

Tappet

Outside Dia. of Shank	0.6222/0.6237 inch (15.80/15.84 mm)
Clearance fit in Cylinder Head	0.00075/0.00350 inch (0.02/0.09 mm)

Rocker Shaft

Outside Dia.	0.6223/0.6238 inch (15.806/15.845 mm)

Rocker Levers

Bush Bore Dia.	0.6245/0.6258 inch (15.86/15.89 mm)
Clearance Fit on Rocker Shaft	0.0007/0.0035 inch (0.017/0.088 mm)

Camshaft Gear

No. of Teeth	50
Gear Bore Dia.	1.9995/2.0010 inch (50.79/50.82 mm)
Clearance Fit of Gear on Spigot	0.0000/0.0025 inch (0.00/0.06 mm)

Idler Gear and Hub

No. of Teeth	90
Bore Dia of Gear	2.1250/2.1266 inch (53.98/54.02 mm)
Dia. of Hub	2.1230/2.1238 inch (53.92/53.94 mm)
Clearance of Gear on Hub	0.0012/0.0036 inch (0.03/0.09 mm)
Gear Hub Width	1.3175/1.3225 inch (33.46/33.59 mm)
Length of Hub	1.3275/1.3325 inch (33.72/33.85 mm)
Gear End Float	0.005/0.015 inch (0.13/0.38 mm)

Crankshaft Gear

No. of Teeth	25
Dia. of Bore	1.4995/1.5010 inch (38.09/38.13 mm)
Spigot Dia. of Crankshaft	1.5000/1.5005 inch (38.10/38.11 mm)
Transition Fit of Gear on Crankshaft	0.001/0.001 inch (0.025/0.025 mm)

Fuel Pump Gear

No. of Teeth	50
Dia. of Bore	1.750/1.751 inch (44.45/44.47 mm)
Pump Adaptor dia.	1.7407/1.7477 inch (44.21/44.39 mm)
Clearance fit of gear on spigot	0.0023/0.0103 inch (0.058/0.26 mm)

Timing Gear Backlash

All Gears	0.003 inch (0.08 mm) minimum

Lubricating Oil Pump Idler Gear

Inside Dia. of Gear Bore	0.750/0.751 inch (19.05/19.08 mm)
Outside Dia. of Bush	0.752/0.7535 inch (19.10/19.14 mm)
Interference Fit of Bush in Gear	0.0010/0.0035 inch (0.025/0.09 mm)
Inside Dia. of Bush-Fitted	0.6562/0.6572 inch (16.67/16.69 mm)
Dia. of Gear Shaft	0.6548/0.6553 inch (16.63/16.64 mm)
Running Clearance of Gear on Shaft	0.0009/0.0024 inch (0.02/0.061 mm)
Gear End Float	0.008/0.023 inch (0.20/0.58 mm)

Lubricating Oil Pump Drive Gear

Internal Dia. of Gear Bore	0.4962/0.4972 inch (12.60/12.63 mm)
Pump Drive Shaft Dia.	0.4990/0.4995 inch (12.67/12.69 mm)
Interference Fit of Gear on Shaft	0.0018/0.0033 inch (0.045/0.08 mm)

Lubricating Oil Pump Clearances

Type	Rotor
Inner Rotor to Outer Rotor	0.0005/0.0025 inch (0.01/0.06 mm)
Inner Rotor end Clearance	0.0015/0.003 inch (0.038/0.076 mm)
Outer Rotor end Clearance	0.0005/0.0025 inch (0.01/0.06 mm)
Outer Rotor to Pump Body	0.011/0.013 inch (0.28/0.33 mm)

Lubricating Oil Relief Valve

Type	Spring Loaded Plunger
Pressure Setting	50/65 psi (3.52/4.57 kgf/cm^2)

Lubricating System

Lubricating Oil Pressure	30/60 psi (2.1/4.2 kgf/cm^2) at maximum engine speed and normal working temperature

Lubricating Oil Filter

Type of Filter	Full Flow
Element Type	Canister
By-pass Setting	13.0/17.0 psi (0.91/1.20 kgf/cm^2)

Lubricating Oil Sump

Capacity	5.5 Lts (1.452 gal). max. Fill to "FULL" mark on dipstick However the sump capacity vary according to application.

Cooling System

Type	Thermo Syphon-Pump Assisted
Coolant Capacity-Engine Only	4.8 litres (1.268 gal) (approx.)

Thermostat

Type	Wax/Bellows	or Blanking Sleeve
Opening Temperature	75° ± 2°C (167°F ± 35.6 °F)	
Fully Open Temperature	89° ± 2°C (192°F ± 35.6 °F)	

Water Pump

Type	Centrifugal
Pulley Bore Dia.	0.6239/0.6247 inch (15.85/15.87 mm)
Shaft Dia.	0.6262/0.6267 inch (15.91/15.92 mm)
Interference Fit of Pulley on Shaft	0.0015/0.0028 inch (0.038/0.07 mm)
Impeller Bore Dia.	0.6250/0.6257 inch (15.88/15.89 mm)
Shaft Dia.	0.6262/0.6267 inch (15.91/15.92 mm)
Interference Fit of Impeller on shaft	0.0005/0.0017 inch (0.01/0.04 mm)
Clearance between Impeller Blade and Body	0.010/0.020 inch (0.25/0.51 mm)
Distance between impeller Rear face to Pulley face	5.531 inch (140.9 mm)

Fuel System

Fuel Oil Specification	Fuel oil should conform to IS:1460/2000 grade-special or Grade A
Fuel Filter Type	MICO Duel filter, 0.5 litre (0.132 gal) capacity, Spin on type (primary and secondary)
Fuel Overflow Valve Type	MICO spring loaded valve
Overflow Valve Location	FIP fuel gallery (or) Fuel Filter
Fuel Feed Pump	Plunger type, Flange mounted on Fuel injection pump and driven by FIP Camshaft

Fuel Injection Pump

Make	Mico, India
Type	Inline
Mounting	Flanged mounted
Pump Rotation	Clockwise (from drive end)
Drive	Gear
Governor	Mechanical RSV
Injection Timing (Spill Timing)	14°+/-1° B.T.D.C.

Alternator

Make	LUCAS-TVS, India
Type	A115
System Voltage	12
Polarity	Negative earth
Rotation	Clockwise
Max. Output current	36 amps

Starter Motor

Make	LUCAS-TVS, India
Type	3SM 114
System Voltage	12
Rotation	Clockwise
No. of Teeth on Pinion	10 or 11
Starter Cable Resistance	0.0017 ohms maximum

NOTE: *The above electrical data is general and can vary with individual applications*

Cold Starting Aid

Device	Thermostart
Voltage	12 Volts
Location	Induction manifold
Height of reservoir above center of Thermostart	(4.5 - 10 inch) 114.3 -254 mm

Section C

Operating and Maintenance

Preparation for Starting

Check the radiator coolant level.

Check the engine sump oil level.

See that there is fuel oil in the tank

Check that the starter battery is fully charged and that all electrical connections are properly made and all circuits in order.

Starting the Engine

If the engine is warm, turn starter switch in a clockwise direction to the position number 4 (see Fig. C.1.)

As soon as the engine starts, release the switch to the position number 2.

Be sure that the starter pinion and engine have stopped rotating before re-engaging the starter motor. Otherwise damage may result.

If weather is cold, turn starter switch to the position number 3 (see Fig. C.1) and hold it there for fifteen to twenty seconds.

Then turn the starter switch to the “HS” position, thereby engaging the starter motor.

If the engine does not start after twenty seconds, return the switch to the position number 3 for ten seconds and then re-engage the starter motor by switching to the position number 4.

As soon as the engine starts, release the switch to the position number 2 .

Starting the Engine (Alternative Method)

With some engines, a different starter switch may be found and the cold start aid operated by means of a separate push button switch.

The cold starting procedure is however the same, i.e.

Switch on by turning the starter switch in a clockwise direction to the first position

Press the heater button for fifteen to twenty seconds and then, with the heater button still pressed, turn the starter switch in a further clockwise direction to engage the starter motor. As soon as the engine starts, release both starter switch and heater button.

Cold Starting Aid

Referring to Fig. C.2 the cold start unit comprises a tubular valve body carried in a holder which screws into the inlet manifold, and surrounded by a heater coil, an extension of which forms an igniter coil. The valve body houses a needle, the stem of which holds a ball valve in position against its seating. The whole is surrounded by an open perforated shield. Fuel oil from the container enters through an adaptor.

When the unit is cold, the ball valve is held closed. On switching on the coil, the valve body is heated and expands, opening the ball valve and permitting the entry of fuel. The fuel is vapourised by the heat of the valve body and when the engine is cranked and air is drawn into the manifold, the vapour is ignited by the coil extension and continues to burn, thus heating the inlet air.

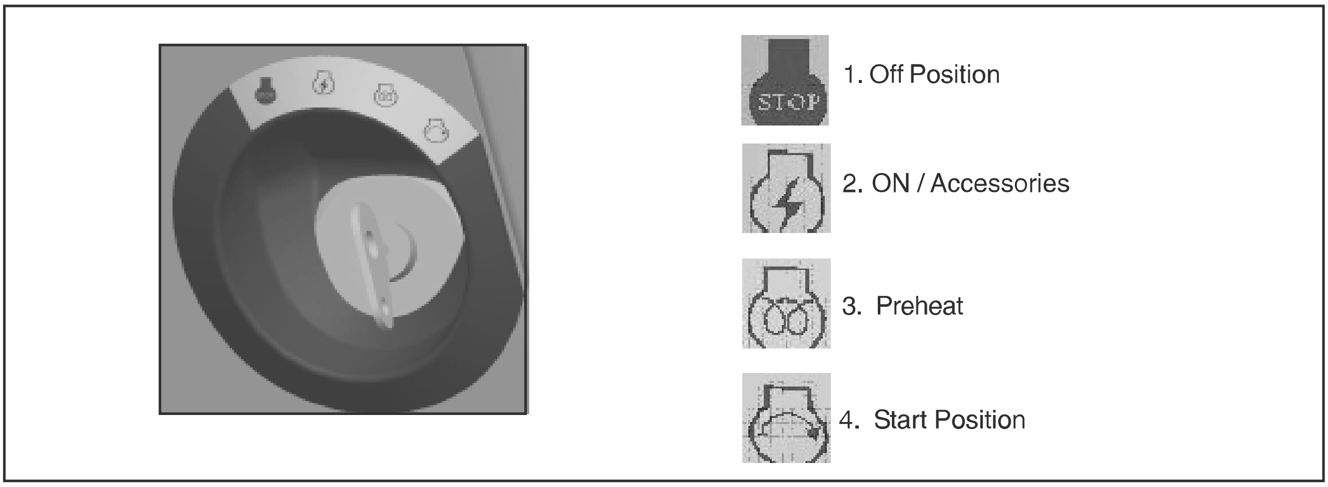


Fig C.1 – Combination Switch

To Stop the Engine

A spring loaded stop control is located near the engine controls and functions by cutting off the fuel at the fuel injection pump.

To operate, pull the knob and hold in this position until the engine ceases to rotate. Ensure that the control returns to the run position, other- wise difficulty may be experienced in restarting the engine.

Turn start switch to the Off position.

Things to Note

Always be sure that the starter pinion has stopped revolving before re-engaging the starter, otherwise the ring or pinion may be damaged.

Ensure that the electrical connection to the cold starting aid is correctly made.

Always ensure that, if a reservoir is used to feed fuel to the starting aid, it is fully primed and is not leaking (Fig. C.3). On later engines, the starting aid fuel feed is taken directly from the fuel filter.

When the coil is switched off, the flow of air in the manifold cools the valve body rapidly and the valve closes.

The cold start aid is a sealed unit and cannot be dismantled. If the unit ceases to function, it must be renewed.

In the event of difficult starting, check that fuel is reaching the cold starting aid in the induction manifold by unscrewing the inlet fuel connection. If fuel is reaching it satisfactorily, then it may be that the cold starting aid itself is not working correctly. This can be checked by removing the air cleaner and watching the cold starting aid when the equipment is used. When the starting switch is turned to the “heat” position, the element should become red hot, and on engagement of the starter motor, it should ignite into flames.

S325.3 engines are fitted with efficient cold starting equipment and no responsibility can be accepted for any damage caused by unauthorised starting aids.

Running-in Procedure

It is not necessary to gradually run-in a new engine and any prolonged light load running during the early life of the engine and in fact prove harmful to the bedding in of piston rings and liners.

Full load can be applied on a new engine as soon as the engine is used, provided that the engine coolant is first allowed to reach a temperature of at least 140° F (60° C).

PREVENTIVE MAINTENANCE

Keep Engine Clean

DAILY OR EVERY 8 HOURS WHICHEVER OCCURS FIRST:

Check level of coolant.

Check level of oil in sump.

Check oil pressure (where gauge fitted).

In extreme dusty conditions, clean air- cleaner regularly.

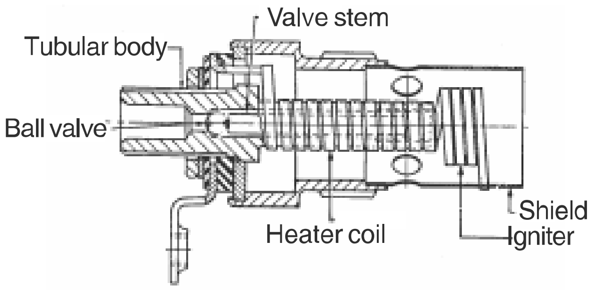


Fig. C2 Thermostart

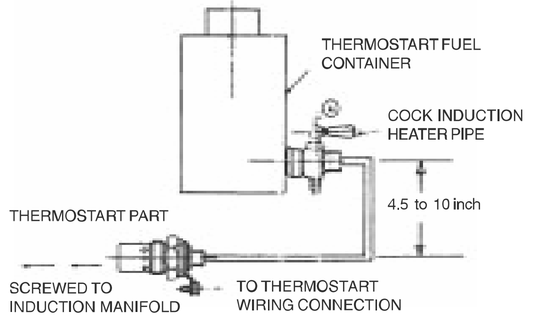

THERMOSTART FUEL CONTAINER
COCK INDUCTION HEATER PIPE
4.5 to 10 inch
THERMOSTART PART
SCREWED TO INDUCTION MANIFOLD
TO THERMOSTART WIRING CONNECTION

Fig. C3 Typical Layout of Cold Start Device

EVERY 250 HOURS:

Drain and renew lubricating oil. Refer to list of Approved lubricating Oils in Sec. Q page 64.

Renew lubricating oil filter element or canister

Check drive belt tension.

Clean oil bath air cleaner and renew oil.

Clean lift pump pre-filter (where fitted).

Check engine for leakage of oil and coolant

Lubricate alternator rear bush (where fitted).

EVERY 500 HOURS.

Check hoses and clips.

Check atomisers.

Examine valve springs and check tappet clearances.

Inspect valve rocker shaft assembly for lubrication.

Clean and treat battery terminals.

EVERY 1,000 HOURS:

Drain fuel tank, remove and clean.

Flush radiator with clean coolant.

Inspect commutator and brushes of dynamo (if applicable).

NOTE: *The time for cleaning the air cleaner depends on operating conditions; therefore under extremely dusty conditions, the time limit recommended above for cleaning should be decreased.*

The correct maintenance of the air cleaner will greatly assist in reducing bore wear, thereby extending the life of the engine.

FUEL FILTERS MAINTENANCE

Do not clean filter inserts.

Drain filter bowls after every 125 hrs. of operation by loosening sludge screws (wherever provided), until clean fuel flows out.

0.5 LITRE DUAL FILTERS (Spin on type)

Replace first stage filter (primary) after every 500 hrs.

Replace second stage filter (secondary) after every 750 hrs.

FUEL INJECTION PUMP MAINTENANCE

(a) Check the oil level every 125 hrs. Drain off excess oil.

Top up fresh engine oil if the level is low.

Replace oil every 2500 hrs.

(b) Clean air breather every 125 hrs. (if provided)

(c) Clean nylon sleeve every 125 hrs. Clean hollow screw with sleeve every 50 hrs. (wherever provided).

Operators of S 325.3 engines are reminded that the above Preventive Maintenance are general in application: therefore the operator should compare the routine maintenance for his engine with the schedules specified by the manufacturer of the application to which the engine is fitted and where necessary adopt the shorter periods.

while we have given specific periods for preventive maintenance, you should have due regard for the local regulations concerning your machine and ensure that the engine is operating within those regulations.

Post-Delivery Checkover

After a customer has taken delivery of their diesel engine, it is advisable, in their own interest that a general checkover of the engine be carried out after the **first 25 hours** in service.

It is also recommended that the following procedure be adopted where an engine has been out of service for a considerable period before it is again put into service.

The checkover should comprise the following points:-

1. Drain lubricating oil sump and re-fill up to the full mark on the dipstick with new clean oil (Do not overfill).
2. Renew the lubricating oil filter (Spin on type).
3. Check external nuts for tightness.
4. Check and adjust tappet clearances 0.012 in (0.30 mm) cold.
5. Check fuel pipes from tank to fuel injection pump for leaks.
6. Check for lubricating oil leaks and rectify if necessary.
7. Check hose clamps for tightness.

8. Check cooling system for leaks and inspect radiator coolant level.
9. Check fan belt for tension.
10. Carry out test to check general performance of engine.
11. Check engine mounting bolts for tightness.

It is assumed that electrical equipment will have already been checked for such points as rate of charge, effectiveness of connections and circuits, etc.

Thereafter maintenance periods should be in accordance with the instructions given.

Preservation of stored Engines

Where an application which is powered by S 325.3 engine is to be stored for several months it is advisable that some measure of protection be afforded to the engine to ensure that it suffers no ill effects during the intervening period before operations are recommenced.

It is recommended, therefore, that the following procedure be adopted and applied immediately when the unit removed from service:

1. Thoroughly clean all external parts of the engine.
2. Run the engine until it reaches operating temperature. Stop the engine and drain lubricating oil from sump.
3. Drain coolant from radiator and engine cylinder block.
4. Clean out engine breather.
5. After replacing filters fill sump to correct level with clean, new lubricating oil or with a suitable preservative fluid.
6. Remove atomisers and spray into cylinder bores 150 ml of lubricating oil divided between the cylinders.
7. Turn engine slowly over compressions and replace atomisers.
8. Remove air cleaner and any intake pipe which may be fitted between the air cleaner and air intake. Carefully seal air intake orifice with waterproof adhesive tape or some other suitable medium.
9. Remove exhaust pipe and seal opening in manifold as in ‘8’.
10. Disconnect battery and store in fully charged condition. Before storing the battery, terminals should be treated to prevent corrosion.

The fuel system may either be drained and charged with a suitable preservative designed for the prevailing climatic conditions or alternatively, it may be left primed with normal fuel oil.

Where the latter course is taken it should be noted that deterioration of the fuel oil may occur during the months the fuel system is idle.

If this occurs, the fuel oil may become contaminated with a wax-like substance which will quickly clog the fuel filtering arrangement once the engine is returned to service.

Therefore, before commencing operations in respect of a unit primed with normal fuel oil which has been idle for several months it is recommended that the fuel tank be drained and the interior of the tank thoroughly cleaned. The fuel oil drained off should be discarded as unfit for further use.

Fuel oil contained in the remainder of the fuel system should also be dispelled and the final fuel filter renewed, following which the system may then be recharged with fresh clean fuel oil.

Before starting, the engine should be cranked over by the starter motor with the stop control in the ’off’ position until oil pressure is recorded or the oil warning light is extinguished. Do not rapidly accelerate the engine after initial start, allow it to run at slow speed for approximately two minutes to ensure good oil circulation before accelerating to higher speeds.

NOTE : *Where a preservative is used in the lubricating oil sump, this should be drained off and replaced by normal lubricant prior to restarting the engine at the end of the storage period. In the case of a preservative being utilised to charge the fuel system, this need not necessarily be drained off before returning the engine to service. Therefore, where a preservative is used in this respect, the relevant manufacturers of the fluid should be contacted seeking their guidance as to whether their product should be drained away prior to restarting the engine.*

Frost Precautions

Precautions against damage by frost should be taken if the engine is to be left exposed to inclement weather either by adequately draining the coolant system or where this is not convenient an anti-freeze of reputable make and incorporating a suitable corrosion inhibitor may be used.

Should it be the policy to protect engines from frost damage by adding anti-freeze to the cooling system, it is advisable that the manufacturers of the relevant mixture be contacted to ascertain whether their products are suitable for use in S325.3 engines, and also to ensure that their products will have no harmful effect on the cooling system generally. It is our experience that the best results are obtained from anti-freeze which conforms to ***British Standard 3151*** or has been approved by testing in accordance with ***BS 5117, Clause 5,*** to give atleast as good a result as ***BS 3151:1959.***

The coolant solution containing 25 per cent ***anti-freeze manufactured to BS 3151*** in coolant in a properly maintained engine should maintain its anti-freeze and anti-corrosive properties throughout the winter season and in general, ***a safe life of 12 months may be reasonably expected.***

When draining the coolant circulating system it is not enough merely to open the radiator drain tap. The one on the cylinder block must also be opened. This tap is on the rear side of the cylinder block, near the flywheel housing.

Where a pressurised radiator filler cap is fitted, this should be removed before draining the cooling system.

When draining the cooling system ensure that the engine is level.

When the engine is drained, in the majority of applications the water pump is also drained, but rotation of the pump may be prevented by :

(a) Locking of the impeller by ice due to the pump drain hole being blocked by sediment.

(b) The locking of the seal through the freezing of globules of moisture between the seal and the gland.

Operators are therefore advised to take these precautions when operating in temperatures below freezing point:

1. Before starting the engine, turn the fan and water pump by hand: this will indicate if freezing has taken place. If freezing has taken place, this should free any ice formation.
2. If it is impossible to turn the pump by hand, the radiator and engine should be filled with warm coolant.

After an anti-freeze solution has been used, the cooling system should be thoroughly flushed in accordance with the manufacturer's instructions before refilling with normal coolant.

If the foregoing action is taken, no harmful effects should be experienced, but the manufacturer cannot be held responsible for any frost damage or corrosion which may be incurred.

SECTION D FAULT FINDING CHART

The following table lists problems and their possible causes with recommended action.

IMPORTANT : *When attending/performing a repair, the cause of the problem must also be investigated and corrected to avoid repeat failures.*

PROBLEM	POSSIBLE CAUSES	REMEDY
LOW CRANKING SPEED	Battery capacity low	Change or renew the battery
	Bad electrical connections	Check the connections or renew electricals
	Faulty starter motor	Overhaul starter motor
	Lubricating Oil of incorrect grade	Drain and refill with specified grade of oil
ENGINE DOES NOT START	Low cranking speed	See Problem – Low Cranking speed
	Fuel tank empty	Fill the tank with fuel
	Incorrect type or grade of fuel	Drain and refill with correct type/grade of fuel
	Faulty stop control operation	Check the stop control cable movement and setting
	Blocked fuel feed/supply pipe	Clean the pipe
	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Chocked/Plugged fuel filters	Renew filter elements
	Air in fuel system	Remove air lock/Bleed air
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Broken fuel injection pump drive	Fit new drive
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor Compression
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Pitted valve/s and seat/s	Replace valve with new standard or oversize, and/ or machine the valve guide bores
	Broken, worn or sticking piston ring/s	Fit new ring/s, check bore and pistons for damage

PROBLEM	POSSIBLE CAUSES	REMEDY
DIFFICULT STARTING	Low cranking speed	See Problem – Low Cranking Speed
	Faulty stop control operation	Check the stop control cable movement and setting
	Blocked fuel feed/supply pipe	Clean
	Blocked fuel tank vent	Clean
	Incorrect type or grade of fuel	Drain the fuel and refill with correct grade of fuel
	Exhaust pipe restriction	Check and clean/remove the restrictions
	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Restricted fuel filters	Renew filter elements
	Restriction in air cleaner or induction system	Check and clean/remove the restriction
	Air in fuel system	Remove air lock/Bleed air
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor Compression
	Sticking valves	Replace valve with new standard or oversize, and/or machine the valve guide bores
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Pitted valves and seats	Replace valve with new standard or oversize, and/or machine the valve guide bores
	Broken, worm or sticking piston ring/s	Fit new rings, check bore and pistons for damage

PROBLEM	POSSIBLE CAUSES	REMEDY
MISFIRING	Restricted fuel feed/supply pipe	Clean pipe
	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Restricted fuel filters	Remove filter elements
	Air in fuel system	Remove air lock/Bleed air
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor compression
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Overheating	See Problem – Overheating
	Incorrect tappet adjustment	Check and reset the adjustment
	Sticking valves	Replace valve with new standard or oversize, and/or machine the valve guide bores
	Incorrect high pressure pipes	Renew the pipes of correct specification
	Pitted valves and seats	Replace valve with new standard or oversize, and/or machine the valve guide bores.

PROBLEM	POSSIBLE CAUSES	REMEDY
EXCESSIVE CRANKCASE PRESSURE	Plugged breather pipe	Clean the pipe
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Worn valve stems and guides	Renew valves and guides
	Piston seized inspect the bore for damage	Replace with new pistons assembly and check/
POOR COMPRESSION	Overheating	See Problem – Overheating
	Incorrect valve timing	Reset the timing
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Incorrect tappet adjustment	Check and reset the adjustment
	Sticking valves	Replace valve with new standard or oversize and / or machine the valve guide bores
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Pitted valves and seats	Replace valve with new standard or oversize, and/ or machine the valve guide bores
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and piston for damage
	Worn valve stems and guides	Renew valves and guides
	Broken valve springs	Fit new springs

PROBLEM	POSSIBLE CAUSES	REMEDY
LACK OF POWER	Blocked fuel feed/supply pipe	Clean the pipe
	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Restricted fuel filters	Remove filter components
	Plugged fuel tank vent	Clean
	Restriction in air cleaner or induction system	Check and clean/remove the restriction
	Air in fuel system	Remove air lock/Bleed air
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Incorrect fuel pump timing	Check and reset
	Incorrect vale/valve timing	Check and reset
	Poor compression	See Problem – Poor Compression
	Incorrect type/grade of fuel	Drain the fuel and refill with correct grade of fuel
	Sticking throttle or restricted movement	Check, clean, lubricate and adjust settings
	Exhaust pipe restriction	Check and clean/remove the restrictions
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Overheating	See Problem – Overheating
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Pitted valves and seats	Replace valve with new standard or oversize, and/or machine the valve guide bores
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage

PROBLEM	POSSIBLE CAUSES	REMEDY
EXCESSIVE FUEL CONSUMPTION	Restriction in air cleaner or induction system	Check and clean/remove the restriction
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul Injectors
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor compression
	Incorrect type or grade of fuel	Drain the fuel and refill with correct grade of fuel
	Sticking throttle or restricted movement	Check, clean, lubricate and adjust settings
	Exhaust pipe restriction	Check and clean/remove the restrictions
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Incorrect tappet adjustment	Check and reset the adjustment
	Sticking valves	Replace valve with new standard or oversize and/or machine the valve guide bores
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Pitted valves and seats	Replace valve with new standard or oversize and/or machine the valve guide bores
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage

PROBLEM	POSSIBLE CAUSES	REMEDY
BLUE/WHITE SMOKE	Incorrect grade of lubricating oil	Drain and refill with specified grade of oil
	Overfilled air cleaner oil or use of incorrect grade (wet type air cleaner)	Check the oil level and remove as necessary or of oil refill with correct grade oil
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor Compression
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Incorrect tappet adjustment	Check and reset the adjustment
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Worn valve stems and guides	Renew valves and guides
	Piston seized damage	Replace piston assembly and check the bore for

PROBLEM	POSSIBLE CAUSES	REMEDY
LOW ENGINE OIL PRESSURE	Incorrect grade of lubricating oil	Drain and refill with specified grade of oil
	Worn or damaged big end bearings	Renew the bearings
	Insufficient oil in sump	Top up as necessary
	Oil gauge faulty	Fit new gauge
	Oil pump worn	Renew oil pump
	Oil pressure relief valve faulty	Fit new relief valve
	Faulty suction pipe	Renew the pipe
	Chocked/Plugged oil filter	Replace with new filter
	Plugged sump strainer	Clean the strainer

PROBLEM	POSSIBLE CAUSES	REMEDY
ENGINE KNOCKS	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Faulty injectors	Overhaul injectors
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Incorrect type or grade of fuel	Drain and refill with correct grade of fuel
	Overheating	See Problem – Overheating
	Incorrect tappet adjustment	Check and rest the adjustment
	Sticking valves	Replace valve with new standard or oversize, and / or machine the valve guide bores
	Worn cylinder bores	Re-sleeve block and fit ne pistons
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Overfilled cleaner or use of Incorrect grade of oil (Wet type Air cleaner)	Check the level or drain out and refill with correct grade oil
	Worn or damaged big end bearings	Renew the bearings
	Piston seized damage	Replace piston assembly and check the bore for
	Broken valve spring	Replace new springs

PROBLEM	POSSIBLE CAUSES	REMEDY
VIBRATION	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Poor compression	See Problem – Poor Compression
	Sticking throttle or restricted movement	Check, clean, lubricate and adjust settings.
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Overheating	See Problem – Overheating
	Sticking valves	Replace valve with new standard or oversize, and/or machine the valve guide bores
	Incorrect high pressure pipes	Renew with pipes of correct specifications
	Broken worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Piston seized damage	Replace piston assembly and check the bore for
	Faulty engine mounting	Check and redo the installation of engine
	Incorrectly aligned flywheel housing or flywheel	Check and align flywheel housing and flywheel
HIGH OIL PRESSURE	Incorrect grade of lubricating oil	Drain and refill with specified grade of oil
	Inaccurate relief gauge	Check and renew gauge
	Pressure relief valve faulty	Fit new relief valve
STARTS & STOPS	Restriction Plugged fuel filter	Fit new filter
	Restriction in air cleaner or induction system	Remove the restriction
	Air in fuel system	Remove the air lock/Bleed air

PROBLEM	POSSIBLE CAUSES	REMEDY
ERRATIC RUNNING	Sticking throttle or restricted movement	Check, clean, lubricate and adjust settings
	Overheating	See Problem – Overheating
	Incorrect tappet adjustment	Check and reset the adjustment
	Sticking valves	Replace valve with new standard or oversize, and/or machine the valve guide bores
	Incorrect high pressure pipes	Renew the pipes of correct specifications
	Broken, worn-out or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Piston seized	Replace piston assembly and check the bore for damage
	Broken valve spring	Replace with new springs

ERRATIC RUNNING	Faulty stop control operation	Check the stop control cable movement and setting
	Resticted fuel feed/supply pump	Clean
	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Plugged fuel filters	Chocked fuel filters
	Restriction in air cleaner or induction system	Check and clean/remove the restriction
	Air in fuel system	Remove air/Bleed air lock
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Poor compression	Renew piston rings or re-sleeve as necessary
	Plugged fuel tank vent	Clean the vent

PROBLEM	POSSIBLE CAUSES	REMEDY
OVERHEATING	Coolant level too low	Top up as necessary
	Loose fan belt	Tighten the fan belt
	Faulty Temperature gauge	Check and replace
	Restriction in coolant jacket	Remove the restriction by reverse flushing entire cooling system
	Plugged radiator	Clean and check for free flow
	Restriction in air cleaner or induction system	Check and clean/remove the restriction
	Damaged fan	Fit new fan
	Faulty thermostat	Replace with new thermostat
	Faulty water pump	Overhaul or renew the water pump
	Exhaust pipe restriction	Remove the restriction
	Faulty injector	Overhaul Injector
	Incorrect fuel pump timing	Reset the timings
	Incorrect valve timing	Reset valve timings
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Faulty fuel injection pump	Overhaul injection pump
	Piston seized damage	Replace piston assembly and check the bore for

Section E
Cylinder Head

The number of hours run has no bearing on when to overhaul the cylinder head because carbon, beyond a superficial coating does not form and accumulate in the combustion chambers and on the pistons as is the case with a gasoline engine.

Ease of starting and performance are the determining factors. Therefore the cylinder head should only be removed when it is absolutely necessary.

To Remove the Cylinder Head

1. Drain coolant from radiator and cylinder block.
2. Detach coolant connections from thermostat housing on front of cylinder head.
3. Remove air cleaner.
4. Detach cold starting equipment connections (if fitted).
5. Remove the oil pipe from the camshaft oil reducer to the cylinder head.
6. Disconnect the exhaust pipe from the engine exhaust manifold.
7. Remove the injection pipes from the fuel pump to atomisers.

WARNING:- Cover the fuel pump delivery ports with suitable protective caps.

8. Remove atomiser leak-off pipes
9. Remove the atomisers. ***In S325.3 engine, only one stud with nut and bracket is being used to retain the atomiser in position on cylinder head.***
10. Remove the cylinder head cover.
11. Disconnect the oil pipe to rocker shaft.
12. Remove the rocker shaft assembly bringing above named oil pipe with it.
13. Remove the cylinder head nuts/setscrews.
14. Remove the cylinder head. Do not insert screwdriver or any other sharp instrument between the cylinder head and block. Place the cylinder head on a flat surface, preferably wood, to avoid damage.

To Remove the Valves

Depress the spring cap, and spring by means of a valve spring compressor and remove the two half conical collets. Remove the spring caps,springs and washers thus freeing the valves for removal. The valves and valve seats should be reconditioned in the normal way, using grinding compound or by means of specialised equipment.

The valve seat angle is 36° and the valve face angle 35°.

Do not forget that the efficiency of a diesel engine depends largely on the maintenance of good compression. Contact between valve and seatings must therefore be the best possible.

Care should be taken to avoid unnecessary grinding away of the seat as the maximum clearance between the valve head and the cylinder head bottom face should not exceed 0.072 inch (1.83 mm) for inlet. The exhaust valve head depth should not exceed 0.083 inch (2.11 mm). This can easily be checked by means of a suitable gauge and feelers.

The valve seats on S325.3 engines, are recessed into the cylinder head and a groove is cut where the proper valve seat ends in the mitred recess in the head. When valves have been reconditioned several times, it is possible that the valve may become masked by sinking too low in the cylinder head and in these circumstances the groove referred to should be re-cut accordingly.

With earlier engines, the valves were numbered and the cylinder head was marked with corresponding numbers.

With current engines the valves and seats are not numbered and where a valve is to be used again, it should be suitably marked to ensure it is replaced in its original position.

Rocker Levers and Bushes

Wash the rocker shaft assembly thoroughly in cleaning solvent.

Examine the rocker bushes for wear. The rockers should be an easy fit on the shaft without excessive side play.

If the rocker bushes are worn, it will be necessary to replace with a new bush and reamed to correct size.

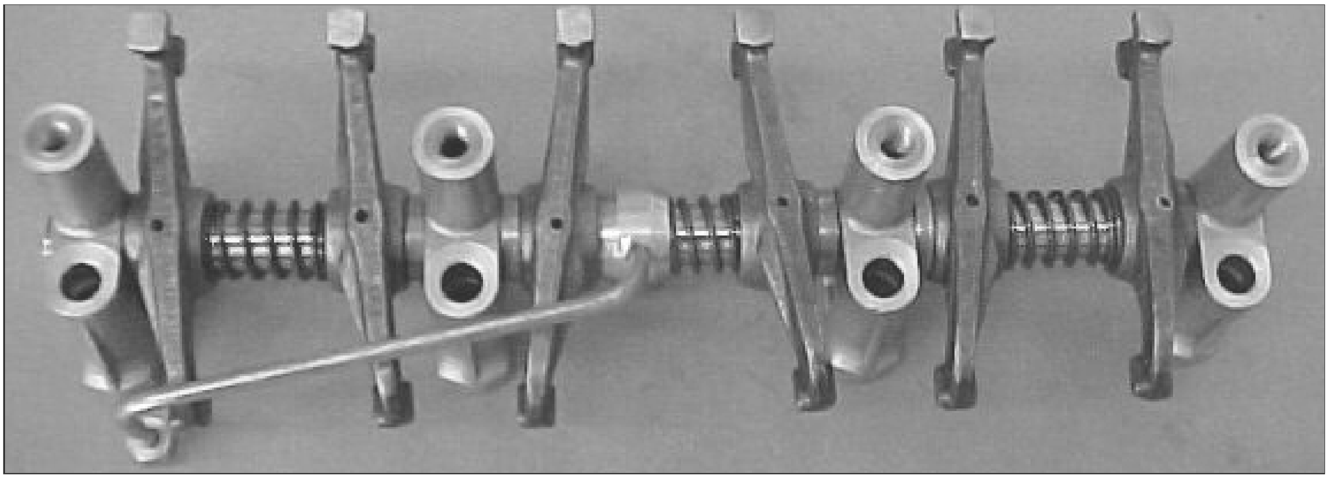


Fig E.1 Rocker Lever Assembly

When dismantling rocker shaft assembly make careful note of the order of assembly of the various parts, supports, spacers, springs and rockers, so that re-assembly may be facilitated and that left and right-hand rockers are correctly placed and opposite of their respective tappets and valves.

Valve Guides

Examine the valve guides for wear, if necessary replace with new guides.

Clean the new guides, removing any burrs.

When pressing in a valve guide, care must be taken to ensure it is installed the correct way. Both ends are chamfered, one at 45°, the other at 20°. The end that is chamfered at 20° is recessed in the bore. This end should be inserted into the cylinder head top face and pulled Into the parent bore until the opposite end (chamfered at 45°) protrudes 0.362/0.376 inch (9.195/9.550 mm) above the top face. Valve stem seal (with metal insert) is fitted over valve guide.

Tappets

The tappets slide in holes bored in the cylinder head. The wear, under normal conditions, is negligible.

The running clearance between the top of the tappet and the rocker should be 0.012 inch (0.30 mm) when the engine is cold.

When adjusting this clearance, tighten tappet locknut effectively, so that it does not loosen in service.

General

All studs on the cylinder head and top face of the cylinder block should be examined for looseness, damaged threads, etc. the cylinder head nuts/setscrews should also be examined to ensure the threads are not damaged.

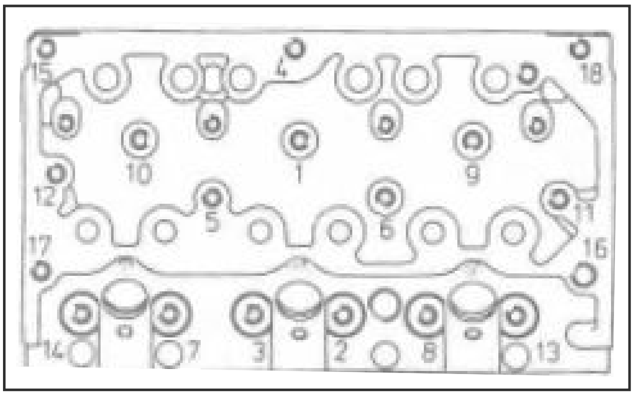


Fig E.2 Cylinder Head Tightening Sequence

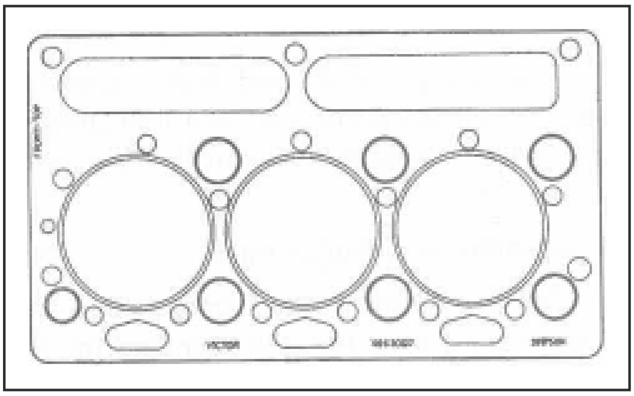


Fig E.3 Cylinder Head Gasket

All joint faces should be examined for pitting and scoring.

Wash out and thoroughly clean the coolant passages in the head subsequently drying out and finally cleaning with compressed air.

If the coolant jacket of the cylinder head shows signs of excessive scale a proprietary brand of descaling solution should be used.

If possible, the cylinder head should be coolant tested for leaks with warm coolant at a coolant pressure of 30 lbf/in^2 (2.11 Kgf/cm^2).

IMPORTANT

The relative valve head depth, however, must afterwards be checked and if necessary corrected to conform with the limits quoted on section B.

Re-assembly and Replacing

Replace valves, washer, spring, collars and collets, taking care that the numbers on the valves correspond to the numbers stamped adjacent to the valve seats. (if Stamped)

On the engines only one spring is fitted to each valve with a spring seating washer.
Before replacing the cylinder head it is extremely important to ensure that the faces of the cylinder block and cylinder head are perfectly clean.

A new cylinder head gasket should be used. The gasket is marked to indicate how it should be fitted **(Marked 'Top Front')** – Ref. Fig. E. 3

Now non-retorque type gasket is being used. It should be fitted dry. This gasket does not require retorquing in Post-Delivery inspection.

When the underface of the cylinder head is perfectly clean, the head may be lowered into position on its studs and the nuts/setscrews pulled down in the order shown in Fig E2. The cylinder head nuts/setscrews should be pulled down to the recommended torque .

Replace atomisers.

Replace the rocker shaft assembly, but before tightening the securing nuts the rockershaft should be set so as to ensure correct lubrication of the assembly. The correct position for the shaft is when the slot in the end of the shaft is set 30° after the horizontal position.

When the rocker shaft is correctly positioned, tighten the securing nuts and set the valve clearance to 0.012 inch (0.30 mm).

Connecting the pipes and make connections as listed under "To remove the Cylinder Head".

Provision is made in the cylinder head coolant outlet for the housing of a thermostat which must be fitted. On no account must the engine be started without a thermostat fitted.

Adjusting Tappet Clearance

The three throw 120° crankshaft makes it necessary to adopt a slightly different sequence for tappet adjustment to the normally accepted procedure for four and six cylinder engines.

Valve clearances for both inlet and exhaust should be set to 0.012 inch (0,30 mm) cold.

To adjust clearances on engines with a flywheel T.D.C. mark proceed as follows:-

Remove the rubber plug in the inspection hole on the flywheel housing.

Rotate the crankshaft until the T.D.C. line on the flywheel is in the center of the inspection hole and No. 1 piston is on compression stroke (both valves fully closed).

NOTE: *In all applications, the T.D.C. marking is given on crankshaft pulley with a pointer on timing case cover.*

Check and adjust clearances as necessary on Nos. 1, 2, 3 and 5 valves.

Turn crankshaft one revolution (360°) and repeat for Nos. 4 and 6 valves (T.D.C. mark visible through inspection hole on flywheel housing or on crank pulley)

Replace rubber plug in flywheel housing.

To adjust clearances without a T.D.C. mark, proceed as follows:-

Turn the crankshaft until the valves of No. 1 cylinder are rocking (inlet valve opening and exhaust valve closing).

In this position, check and adjust clearances, as necessary, on Nos. 4 and 6 valves (No. 1 valve at front of engine).

Temporarily mark the crankshaft pulley and the adjacent point on the timing case cover and turn the crankshaft one complete revolution (360°) until the marks re-align.

In this position, adjust the clearances on Nos. 1, 2, 3 and 5 valves.

Section F
Pistons and Connecting Rods

The pistons are of special light aluminium alloy with a re-entrant bowl in the crown (Fig. F-1). They are secured to the connecting rods by means of fully floating gudgeon pins which work in thin wall steel backed lead bronze lined bushes fitted in the small ends of the connecting rods. Circlips are provided in the pistons to secure the gudgeon pins in position. Three rings are fitted to each piston. All the piston rings are fitted above the gudgeon pin.

The connecting rod big ends are split at right angles to the axis of the rods, the caps being secured by two bolts and nuts.

Always ensure that big end nuts are replaced by new, once they are removed.

The big end bearings are of the thin wall type consisting of a thin steel shell lined with aluminium tin.

To ensure correct replacement, the pistons are marked 1 to 3, number 1 being at the front of the engine. The number can be found stamped on each piston crown.

The connecting rods and caps, are also marked. On one side they are stamped with a number corresponding to their position in the engine.

To Remove Pistons and Connecting Rods

1. Remove cylinder head assembly (Ref. Section E).
2. Remove sump
3. Remove oil pump
4. Turn the engine until number one connecting rod is at bottom center. Remove bolts and nuts securing the connecting rod cap.
5. Remove the connecting rod cap and both top and bottom half bearing shells.
6. The piston and connecting rod can then be pushed out of the top of the cylinder block.
7. Continue operations until all three pistons and connecting rods have been removed.
8. Keep all pistons, connecting rods, caps, bearing shells, bolts and nuts together as separate assemblies, each to each as marked.

To Remove Gudgeon Pins

Remove the circlips from the pistons, using a pair of long nosed pliers.

The gudgeon pins can now be removed and the connecting rods separated from the pistons. If the pins are tight in the pistons, warm the latter in liquid to a temperature 100° to 120°F (38-49°C) which will free the pins.

To Fit New Small End Bushes

The small end bushes are a press fit in the connecting rods.

Press out the old bushes using a suitable press.

Remove any sharp edges around the connecting rod small end parent bores.

Press in the new bushes using a suitable tool, at the same time ensuring that the oil holes in the bushes coincide with the holes in the top of the connecting rods.

Ream out the new bushes in situ to suit their respective gudgeon pins (Section B / Page 9), and check for parallelism and twist. (Section B / Page 10)

To Assemble Pistons and Connecting Rods

If the original pistons are to be used again they should be re-assembled to their respective connecting rods, i.e., the piston stamped No. 1 should be fitted to the connecting rod stamped No. 1.

Pistons for the S 325.3 engine should be fitted with the offset cavity in the crown towards the side of the connecting rod that is marked with the identification number towards FI Pump side.

Assemble the connecting rod to the pistons and insert the gudgeon pin. If the pins are tight in the pistons, warm the pistons in liquid to a temperature of 100° to 120°F. (38° to 49°C) The gudgeon pin can then easily be pushed into position.

Fit the circlips to the piston. It is difficult to advise as to when new circlips should be fitted, but in the event of an engine being in service for a lengthy period it is advisable that new circlips be used, during re-assembly.

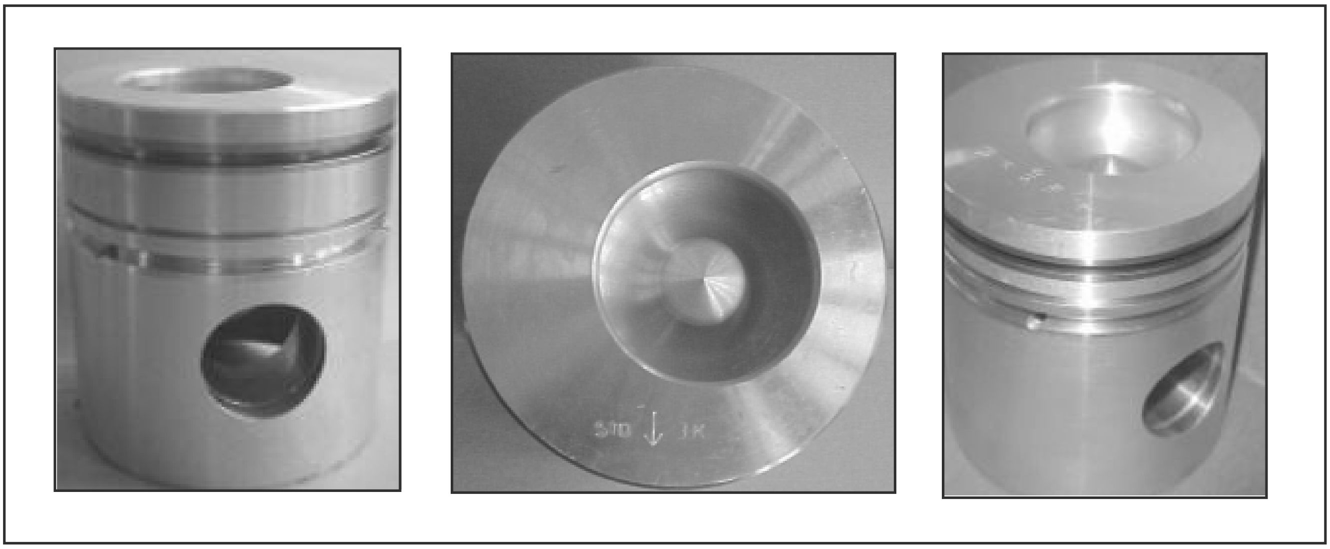


Fig F.1 Piston with re-entrant bowl (ALFIN type)

Fitting New Rings (Ref. Fig. F2)

The piston and rings should be thoroughly washed to remove any oil and grease.

Check piston rings for correct gap (Ref. Section B / Page 9).

In worn cylinder bores, the gaps should be checked at the unworn top of the bore, after any carbon has been removed.

Fit the rings to the piston in the following position (reading from the top of the piston).

1. Ring compression (Chromium inlaid, Half Keystone with 'Top' marked).
2. Ring compression (Cast Iron, Taper land with 'Top' marked).
3. Conformable oil control Ring

When fitting new rings to original pistons clean out the piston ring grooves using the old ring and or a piston ring groove cleaner.

The pistons should be carefully examined for bruising of the ring grooves and to ensure that the rings move truly in their grooves. In addition the piston skirt should be examined and if there is any scoring, the piston must not be used again.

To Fit Conformable oil Ring

1. Fit the helical coil spring onto the 3rd groove of the piston.
2. Insert the latch into the coil spring aligning both the ends.
3. Fit the outer C.I. ring over the coil spring. Ensure coil spring gets seated properly inside the ring groove.
4. Also ensure the coil spring latch is on the opposite side of the ring open end gap.

To Replace Pistons and Connecting Rods

Connecting rods and caps, are plainly marked to indicate their original position in the engine. The numbers are stamped on that side of the connecting rod and cap which is machined to take the locating lips of the big end bearings.

Before fitting pistons, the cylinder bores should be given a liberal coating of clean lubricating oil.

When fitting pistons and connecting rods to the cylinder block and crankshaft, ensure that the side of the connecting rod which is stamped with the number goes to the fuel pump side of the engine.

For S 325.3 engines, ensure that the word "F"/arrow marked on the piston crown is towards the front of the engine.

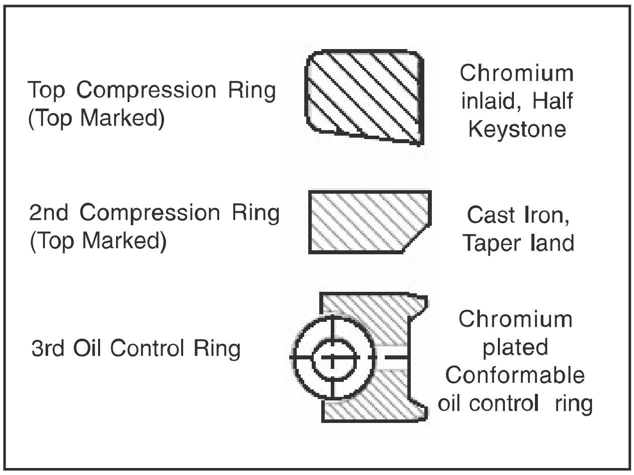


Fig F.2 Ring layout

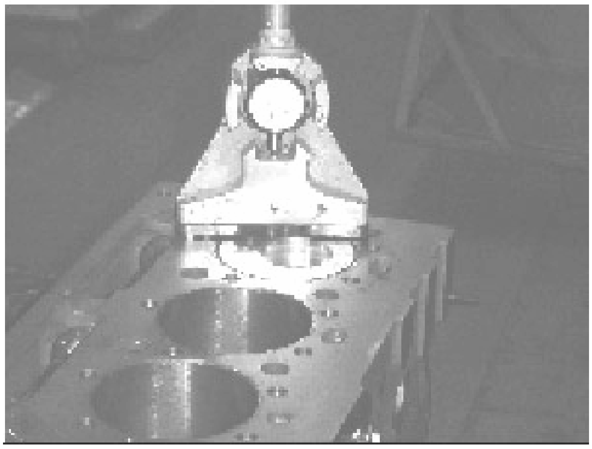


Fig F.3 Checking Piston topping limit

Insert the pistons and connecting rods into the cylinder bores from the top, ensuring the piston and rod stamped No. 1 are fitted into No. 1 bore and No. 2 into No. 2 bore and so on commencing from the front of the engine.

To minimise the possibility of breaking piston rings it is advisable to use a piston guide. Take care not to damage the rings. Should the piston accidently drop partly into the cylinder bore and is held suspended by a piston ring, it must be taken out again and the ring examined to see if it is cracked or broken.

Turn the crankshaft until the appropriate crankpin is at bottom center, pull the connecting rod to the crankpin and insert the half bearing.

Fit the cap and cap half bearing, ensuring that the markings on connecting rod and cap coincide.

The nuts used on the big end bolts should not be used a second time but should be replaced by new whenever they are removed.

Tighten the connecting rod nuts using a torque wrench set to the tension given on Section B / Page 6.

Rotate crankshaft by hand and note that all parts move freely.

Check the piston height in relation to the top face of the cylinder as described below.

Fitting New Pistons

An important point to note is that when the crankpin is at top dead center the crown of the piston must be 0.005 / 0.002 inch (0.150 / 0.060 mm) above block surface.

Pretopped pistons are being used with letter “L” or “H” marked on piston crown for identification

“L” – Low grade / “H” – High grade.

(***NOTE :*** *This grade does not refer to material grade.*)

To determine the piston level, the piston assembly and connecting rod should be fitted to the cylinder block and crankshaft as previously described.

When assembled, turn the crankshaft to bring the piston to T.D.C. and check the distance between the piston crown and the top face of the cylinder block as shown in Fig. F.3.

Carry out this operation with each new piston in turn. If necessary, it has to be replaced by another new piston. The piston should not be machined for any reason in an attempt to correct this height.

The distance between the cylinder block face and piston crown should now be checked to ensure the limit has been maintained when the piston is at Top Dead Center (TDC).

Section G
Cylinder Block and Liners

The cylinder block is fitted with renewable thin wall cast iron dry cylinder liners. The cast iron cylinder liners are an interference fit and require boring and honing to size after fitting.

Cylinder liners fitted to S 325.3 engines cannot be rebored. When they are worn to an extent whereby engine performance is affected, they should be renewed.

To Remove Liners

1. Remove cylinder head as detailed in Section E.
2. Remove the piston and connecting rod assemblies, crankshaft and all component parts of the cylinder block as detailed in the appropriate sections of this manual.
3. Remove cylinder head studs from the cylinder block.
4. Press or draw the liners out through the top of the cylinder block ensuring no damage is done to the parent bores *(cast iron production liners are an interference fit and should be removed with a heavy duty press).*

Preparation for Fitting New Liners

Great care must be taken in handling, transit and storage of new liners.

After removal of the old liners, the parent bore must be thoroughly cleaned both in the top recess of the liner flange and in the parent bore itself.

A check must be made to ensure that the whole areas of contact with the liners in the cylinder block are free from burrs, corrosion or damage. Remove any burrs present.

Ensure that the new liner is thoroughly clean before fitting. If cleaning fluid is used to wash the liner, it is important that the liner parent bore be thoroughly dried and well oiled before fitting.

Throughout the whole operation, extreme cleanliness is essential as the entry of the smallest particle of grit or other foreign matter is sufficient to cause local distortion of the liner bore.

To Fit New Liners

1. Lubricate the outside diameter of the liners with clean oil which should be applied by means of a pressure can. The use of a brush is not recommended.
2. Press or draw in the new liners using a suitable shouldered metal disc ensuring that the flanges at the top of the liners do not foul the counter-bore at the top of the parent bore thus causing distortion at the top of the internal diameter of the liner.

When fully seated, the top face of the liner flange should be between 0.002 inch (0.05 mm) above 0.004 inch (0,10mm)below the top face of the cylinder block. For service liners, the acceptable limit is *3.6015 / 3.6025 inch (91.48 / 91.50 mm).* Each new liner should be checked in three positions – top, center and bottom; the readings being taken transversely and parallel to the center line of the cylinder block at each position.

Having fitted the new liners, the remainder of the re-assembly operations are a reversal of the removal procedure.

To fit New liners (Pre finished liners)

If desired and where the necessary boring equipment is available, unbored cast iron liners (as used in factory production) may be used to replace existing cast iron liners. These are an interference fit in the cylinder block as compared with the transitional fit of pre-finished liners and require boring and honing into a diameter of *3.6015/ 3.6025 inch (91,48 / 91,50 mm)*

For best results the bores should be diamond honed at an inclusive angle of 30° to 35° followed by plateau honing at an inclusive angle of 15° to 35° to a finish of 32/48 micro inches (0.8/1.2 microns) center line average.

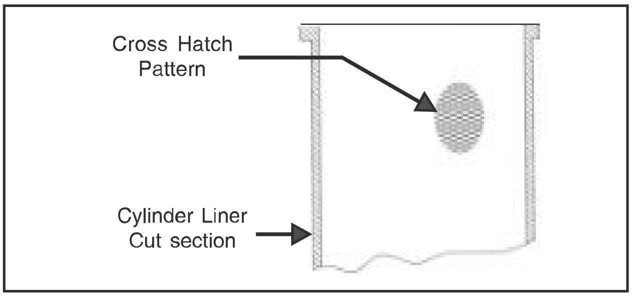


Fig. G 1 Cylinder liner / Hatch pattern

Section H

Crankshaft and Main Bearings

The crankshaft runs in four pre-finished re-placeable shell bearings lined with aluminium tin.

The crankshaft is fitted with two cast iron counter weights, one at the front crank web and one at the rear crank web to give full rotating balance.

The main bearings are located in position by tabs fitting into slots machined in the bearing housings.

The seal at the rear end of the crankshaft is a lip seal fitted in a one-piece housing.

Fitting New Main Bearings and Thrust Washers

Under normal circumstances, by the time the main bearings and thrust washers require renewing, the crankshaft will need to be removed for regrinding. However, if for any reason one or more of the bearings or thrust washers have to be renewed or removed for inspection, this can be carried out without removing the crankshaft from the engine.

1. To remove a main bearing, take off the cap of the bearing in question. For the rear main bearing cap, see (1) in next column.
2. Do not remove more than one bearing cap at a time.
3. Loosen the remaining bearing cap set screws one or two turns.
4. Remove the lower half of the bearing from the bearing cap.
5. With a suitable piece of wood push out the top half of the bearing by rotating it on the crankshaft, applying the tool to the side opposite the bearing lip. The locating lips are on the camshaft side of the engine.
6. Inspect the bearing shells and if they require renewing, insert a new half bearing in the top, inserting the plain end first. Fit new half bearing to cap.
7. Replace cap and tighten setscrews lightly before proceeding to the next bearing.
8. Having replaced the bearing and caps, pull down the setscrews with a torque wrench set to the tension given on Page 6.

The thrust washers fit in recesses provided on either side of the rear main bearing housing and cap.

1. To renew the thrust washers, remove the rear main bearing cap. Before doing this it will be necessary to release the lip seal and housing.
2. Remove the two bottom half thrust washers from the main bearing cap.
3. The two top half thrust washers can be removed by sliding them round from one side with a piece of wood or similar material and rotating them until they can be removed.
4. To fit new thrust washers, lightly coat the two upper halves with lubricating oil and slide in the recesses provided on either side of the rear main bearing housing. The steel side of the thrust washers should be towards the bearing housing.
5. Renew the main bearing cap “O” rings (lip seal crankshafts only). Lightly coat the grooves machined in the cap butt faces with jointing compound and ensure that the grooves are free of jointing compound.
6. Place the two lower halves of the thrust washers on either side of the rear main bearing cap and replace the cap.
7. The bearing cap securing setscrews should be pulled down with a torque wrench set to the tension given on page 6 Check crankshaft end float.
8. Refit the lip seal and housing.

To Remove Crankshaft

1. Remove sump and lubricating oil pump (Ref. Section L / Page 51).
2. Remove water pump (Ref. Section M / Page 56).
3. Remove crankshaft pulley.

4. Take off timing case front cover and remove idler gear.
5. Remove starter motor, flywheel & flywheel housing. When removing the flywheel, fit two guide studs in the crankshaft flange for support.
6. Remove connecting rod caps and big-end bearings.
7. Remove the bolts securing the lip seal housing and remove.
8. Remove setscrews and remove main bearing caps and half bearings.
9. Lift out crankshaft.

Should it be necessary to replace the crankshaft gear, it should be ascertained that the scribed timing mark is to the front when the gear is fitted. The distance piece between the gear and the crankshaft should be fitted with the chamfer to the inside.

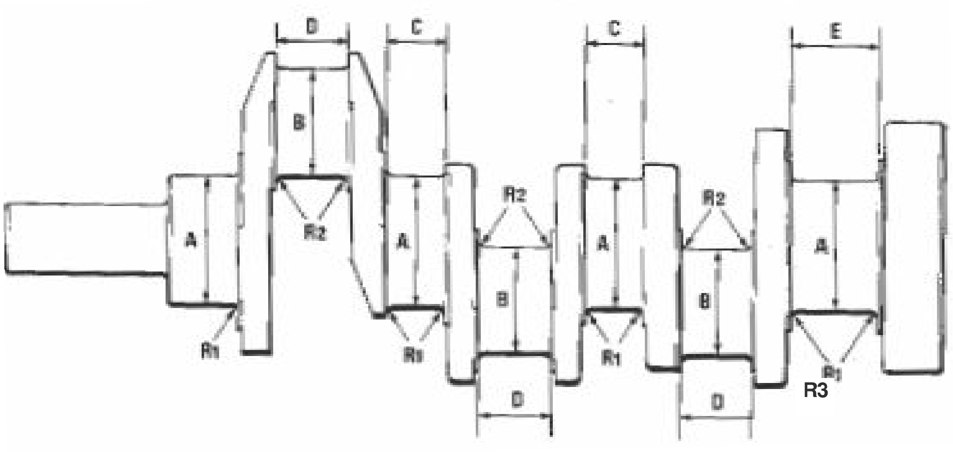
If the main bearings are to be used again they should be suitably marked so that they may be installed in the same position from which they were removed.

Balance Weights

Should it at any time be necessary to replace crankshaft balance weights, these are normally supplied in wired pairs and must be fitted as a pair. Should a single balance weight require replacing, this must be done selectively so that there is no greater weight variation than 1 oz (0.028 Kg.) between individual weights. (Refer Fig. H 6)

Regrinding the Crankshaft

Before proceeding to regrind the crankshaft, the following points should be checked to ensure it is suitable for futher machining.



	0.010 in (0,25 mm) **Undersize**	0.020 in (0.51 mm) **Undersize**	0.030 in (0,76 mm) **Undersize**
A.	2.7385/2.7393 inch (69,56/69,58 mm)	2.7285/2.7293 inch (69,30/69,32 mm)	2.7185/2.7193 inch (69,05/69,07 mm)
B.	2.2384/2.2392 inch (56,86/56,88 mm)	2.2284/2.2292 inch (56,60/56,62 mm)	2.2184/2.2192 inch (56,35/56,37 mm)

C. 1.2277 inch (31,184 mm) maximum
D. 1.575 inch (40,00 mm) maximum
E. For crankshafts with lip type rear seal .- [1.861 inch (47.27 mm) maximum]
R1 0.125/0.140 inch (3,1813, 56mm) all journals Except Rear
R2 0.1875/0.2031 inch (4,76/5,16 mm) all crank pins
R3 0.1562/0.1662 inch (3,97/4,22mm)
Surface finish of crankpins, journals and fillet radii 16 to 8 micro inches (0,4/0,2 microns) C.L.A.

Fig. H1 Crankshaft

(a) The crankshaft should be crack-detected before regrinding. It must, of course, be remembered to demagnetise the crankshaft after crack-detecting, in order to remove any polarisation which may be present.

(b) The main journal and crankpin diameters should be checked to ascertain the next appropriate under size to which the crank- shaft can be-reground, i.e. 0.010 inch (0.25 mm), 0.020 inch (0.51 mm), or 0.030 inch (0.76 mm). Ref. Fig H 1.

If the crankshaft requires to be reground below 0.030 inch (0.76 mm) it is recommended that a new crankshaft is fitted.

During regrinding, all the limits must be adhered to, and the main journals and crankpins must be free from grinding marks.

NOTE: *It is important that the RADII on the main journals and crankpins are maintained. If these are neglected, a fatigue fracture is liable to occur.*

After regrinding, the sharp corners on the oil holes should be removed and the crankshaft crack-detected again and demagnetised.

Replacing Crankshaft

1. Ensure that all oil-ways are clear.
2. Check main bearing setscrews for stretch or damage to threads. Affected setscrews must be scrapped.

In no case should setscrews other than those supplied by the engine manufacturer be used as they are of special heat treated highgrade steel.

3. Clean bearing housing and place top half bearing in position.
4. Place crankshaft in position.
5. Lightly smear the two upper thrust washers with lubricating oil and slide in to the recesses provided on either side of the rear main bearing housing, with the steel side or plain surface of the washers towards the housing.
6. Fit lower halves of main bearings to bearing caps and place in position ensuring that the thrust washers on No. 4 main bearing cap are fitted correctly.
7. Renew the rear main bearing cap “O” rings as shown in Fig. H 7
8. Lightly coat the rear main bearing cap butt faces with jointing compound, only coat outboard of the grooves machined in the cap butt faces and ensure that the grooves are free from jointing compound.
9. When replacing the main bearing caps, ensure that they are fitted in their respective positions, also that they are fitted the correct way round. The caps are numbered, No. 1 commencing at the front of the engine. Each cap is also marked with a serial number and when fitted, this number should read in line with the serial number stamped on the cylinder block bottom face.

For final tightening of the setscrews, a torque wrench should be used, set to the tension given on page 6.

When refitting the crankshaft pulley, ensure that the pulley setscrew is tightened to the correct torque as given on page 6.

Re-assemble engine as required and to the instructions given for the various operations.

Lip Type Crankshaft Rear End Oil Seal

A circular, spring loaded, lip seal is fitted, which locates on the periphery of the flange of the crankshaft. On production, this seal is fitted with its rear face flush with the rear face of the single piece housing.

This type of seal is easily damaged and extreme care should be taken when handling and fitting it to its housing or to the crankshaft. Any visual damage across the lip of a new seal will cause leakage and prevent bedding in of the new seal.

The seal is designed to function correctly with the direction of rotation of the engine and for identification purposes, the seal is marked with an arrow.

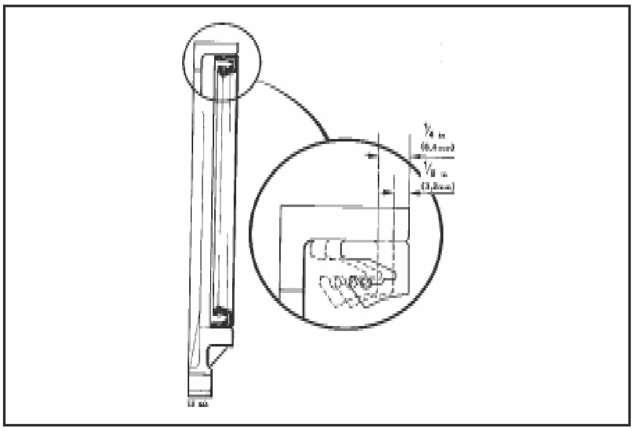


Fig. H.2 Crankshaft Seal – Single Lip (Old Type)

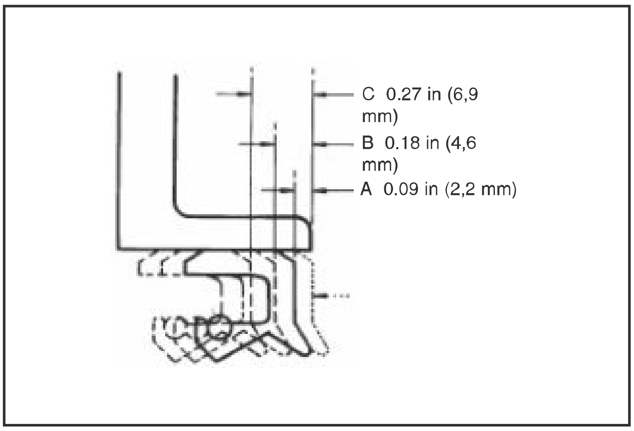


Fig. H.3 Crankshaft Seal – Double Lip (New Type)

Earlier seals have a flat face as shown in Fig. H 2. Later seals have a protruding dust lip from the rear face as shown in Fig. H 3.

To Fit Lip Seal in its Housing

On production, the old type seal was fitted flush with the rear face of the housing (Fig. H 2) but the new type seal is fitted deeper into the housing at ’A’ (Fig. H 3)

In service, when a new seal is fitted to a worn crankshaft, it should be pressed further into the housing. In the first instance it can be pressed in to 1/8 inch. (3.2 mm) for old type seals or position ’B’ for new type seals or, if this position has been used, to 1/4 inch. (6.4 mm) for old type seals or position ‘C’ for new seals.

If a new type seal is used in place of an existing old type seal, position’C’should be used if the old seal was fitted 1/8 inch (3.2 mm) below the housing face.

If all three positions have been used, it may be permissible to machine the worn sealing area of the crankshaft flange but not the spigot area on which the flywheel locates (Fig. H 4)

When a new seal is fitted to a new or reconditioned crankshaft in service, it should be fitted in the production position, but if latest seal is not to be used in a wet back end application, it must be fitted flush with the housing rear face ‘D’ (Fig. H 2)

When pressing in the latest type seal, ensure that the adaptor has a suitable recess to clear the protruding dust lip. Seal guide can be used with both type seals.

Before fitting the seal in the housing, carefully examine the seal for damage, especially on the lip and outside diameter.

Using clean engine lubricating oil, lubricate the outside diameter of the seal and the inside diameter of the housing.

Press the seal into the housing to the required position, taking care that the seal is entered and pressed in squarely, otherwise damage to the outside diameter of the seal may occur, or if it is not square in the housing when fitted to the engine, it may leak.

The seal and housing should be fitted, using suitable seal guide as follows:-

Clean the faces of the cylinder block and oil seal housing, and the outside diameter of the crankshaft flange.

Check that the seal and the outside diameter of the crankshaft flange are not damaged. Where a new seal has been fitted, check that it is in the correct position as previously detailed.

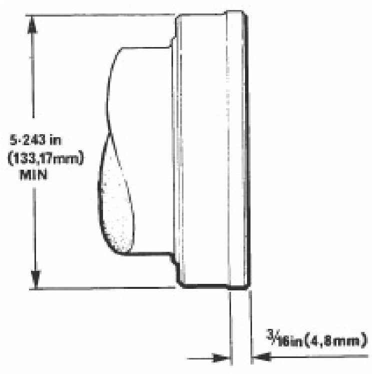


Fig. H.4 Crankshaft Flange Machining dimension

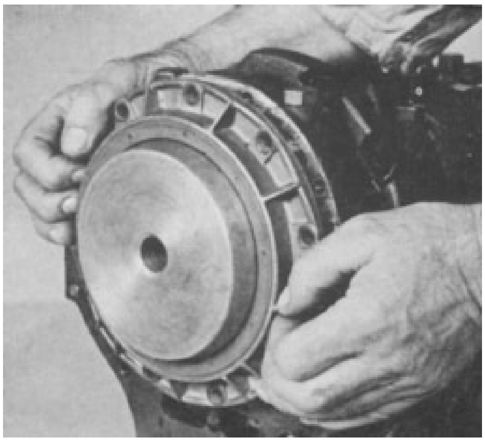


Fig. H.5 Crankshaft Seal Housing Fitting

Ensure that the two dowels are fitted in the cylinder block. Coat both sides of the joint with jointing compound and position the joint over the dowels in the block.

Using clean engine lubricating oil, lubricate the crankshaft flange, the seal and the seal guide.

The lubrication of the seal is necessary to prevent damage that may be caused by initial dry running.

Position the seal and housing on the seal guide, locate the guide on the crankshaft flange and gently press the seal and its housing into position on the flange, locating the housing on its dowels (See Fig. H 5)

Withdraw the guide and secure the housing with setscrews and washers.

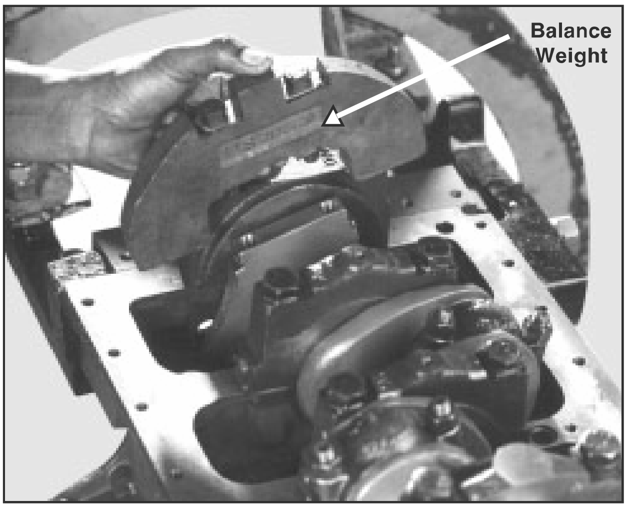


Fig. H. 6 Balance Weight

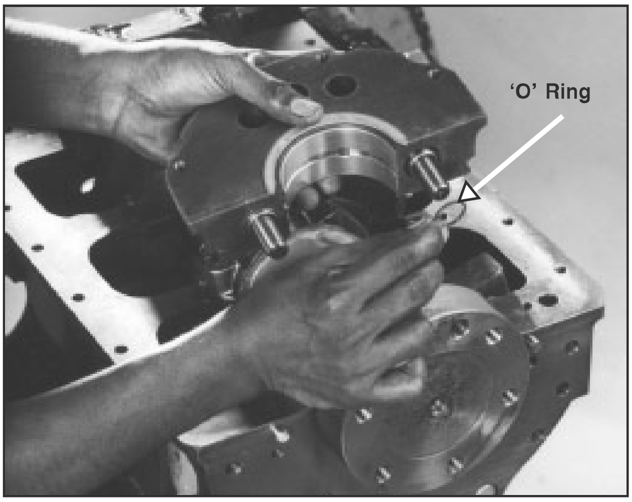


Fig. H. 7 Rear Main Bearing Cap 'O' Ring

Section J

Timing Case and Drive

The camshaft is carried high up on the off side of the cylinder block, the construction of which eliminates push rods.

It is driven from the front of the crankshaft by means of gears.

The timing gears are enclosed by a diecast timing case cover.

To Remove the Timing Case Cover

1. Loosen the dynamo/alternator mounting bolts and remove the fan belt.
2. Loosen off the hose on the hoses fitted to the water pump and remove the water pump.
3. Remove the setscrew crankpulley and washer, the setscrew is of a normal right hand thread into the crankshaft.
4. Remove the crankshaft pulley.
5. Remove the engine breather pipe.
6. Remove the alternator
7. Remove the alternator brackets and adjustable linkage.
8. Remove the timing case cover setscrews Two long bolts pass through the timing case to secure a cover at the rear of the timing case, blanking off the power take off bore. In addition one long bolt (top right) secures the water pump body to the cover and the timing case.
9. Remove the timing case cover taking care not to damage the crankshaft front oil seal which is located in the timing case cover.

To Renew the Crankshaft Front Oil Seal

1. Carefully extract the oil seal from the timing case cover using a suitable press.
2. Locate a new seal in the timing case cover with the lip of the seal towards the inside of the cover.
3. Seals encased with a metal rim should be coated with jointing compound before being pressed into the timing case cover bore.
4. Press the new seal in position using a suitable dolly to ensure the seal is square in the bore of the cover.

To Replace the Timing Case Cover

1. Clean the jointing faces of the timing case and its cover using a new joint, refit the cover and water pump taking care not to damage the front crankshaft oil seal as the cover is placed over the crankshaft front end.
2. For purposes of centralizing the cover around the crankshaft, fit the pulley to the crankshaft and fix the position of the cover to the timing case by two or three setscrews. Remove the pulley and refit all the setscrews to the timing case.
3. Refit the engine breather pipe.
4. Replace the crankshaft pulley, washer and dognut or setscrew.
5. Refit the hoses to the water pump and tighten the clamps.
6. Replace the alternator bracket, alternator and fan belt and tighten the alternator retaining bolts.

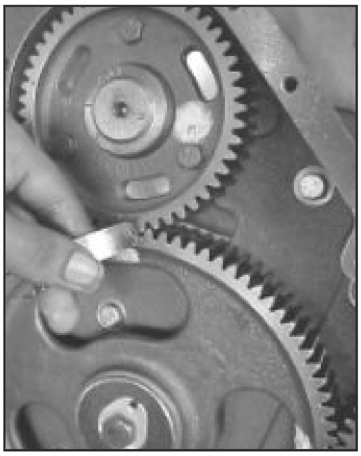


Fig. J.1 Cam Gear / Idler Gear backlash

Timing Gears

The camshaft and the fuel pump gears are driven by the crankshaft gear through an idler gear. All the gears are suitably marked during production to facilitate retiming the marks being in line when No. 1 piston is at top dead center on its compression stroke. It will be appreciated that these timing marks will not align at every rotation of the crankshaft where No.1 piston is at T.D.C. compression.

If it is necessary to replace any of the timing gears, ensure that there is a minimum backlash of 0.003 inch (0.08 mm) – Ref. Fig. J1.

The backlash between the crankshaft gear and oil pump idler gear should be 0.0075 in to 0.0125 inch (0.19 to 0.32 mm) – Ref. Fig. J 2.

To Remove the Idler Gear and Hub

1. Turn the crankshaft until all the timing marks on the gears are in mesh with the idler gear.
2. Bend back the locking washer on the idler gear retaining setscrew, and remove the setscrew, locking washer and idler gear retaining plate.
3. Remove the idler gear from its hub.
4. Remove the idler gear hub from its machined location in the timing case. (Ref. Fig. J 3).

To Replace the Idler Gear and Hub

1. Replace the idler gear hub so that the small locating peg is entered into the through drilling in the hub, ensuring the hub is fully located. The flange of the hub should be flush with the timing case.
2. Fit the idler gear on the hub with the long tapered center boss towards the cylinder block and the timing marks aligned.
3. Replace the idler gear retaining plate, locking washer and retaining setscrew. Fully tighten the setscrew with a torque wrench and bend up the locking washer. Ensure that the idler gear has end float on the hub. The end float should be between 0.005 in to 0.015 in (0.13 to 0.38 mm).

To Remove the Camshaft Gear

1. Release and remove the three securing setscrews and washers.
2. The camshaft gear may now be removed from the camshaft

To Replace Camshaft Gear

1. Remove idler gear and release the rocker assembly to facilitate turning of camshaft. On the spigot of the camshaft will be seen the letter “D” stamped adjacent to a fixing hole and on the camshaft gear another letter “D” will also be seen stamped adjacent to a fixing hole. Install the camshaft gear to the camshaft, ensure the holes with the latter “D” stamped adjacent to them are in line.
2. Replace and secure the three washers and setscrews.
3. Turn the camshaft until Nos. 4 and 6 cams are upright, this can be checked by watching the tappets, and this is the approximate position for aligning timing marks.
4. Fit idler gear, aligning all timing marks and secure the rocker assembly.

To Remove the Fuel Pump Gear

1. Remove the idler gear.
2. Release and remove fuel pump gear securing setscrews.
3. Remove fuel pump gear, taking care not to damage the dowel.

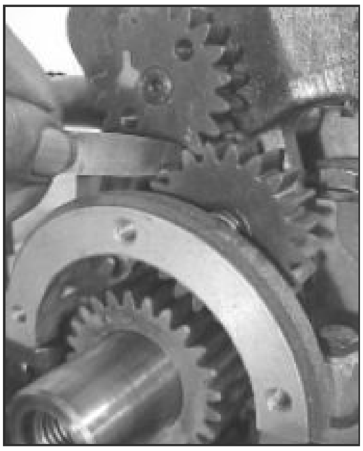


Fig. J.2 Checking Oil pump idler gear backlash

To Remove the Fuel Injection Pump

The fuel injection pump is secured to the back of the timing case on the left-hand side of the engine and the fuel pump driving gear is securely attached to the shaft of the pump by three setscrews. The location of the gear to the pump shaft is determined by a dowel.

On the timing case front cover is a small inspection cover and removal of this cover gives access to the setscrews securing the driving gear to the pump.

1. Turn the engine to T.D.C. No. 1 cylinder on compression.
2. Remove the fuel pipes to the pump and blank off all ports against the ingress of dirt.
3. Remove the throttle and stop controls from the governor housing of the pump.
4. Remove the cover from the timing case front cover.
5. Carefully remove the three setscrews and washers securing the gear to the fuel pump, great care must be exercised in removing these setscrews for should one be dropped into the timing case, considerable time and labour would be involved in recovering it.
6. Release and remove the three nuts,flat and spring washers securing the flange of the fuel injection pump to the back of the timing case.
7. Remove the fuel injection pump.

To Replace the Fuel Injection Pump

1. Check that the slot in the fuel pump shaft is in approximate position to the dowel in the gear and install the pump to the three studs on the back of the timing case and retain with the three falt and spring washers and nuts, but do not tighten the nuts.
2. After ensuring that the dowel in the fuel pump driving gears is located to the slot in the fuel pump shaft, secure the gear to the pump by the three setscrews and spring washer taking care not to bind the gear on the pump shaft.
3. Tighten the three securing nuts.
4. Replace the inspection cover to the timing case front cover.
5. Replace the throttle and stop control.
6. Refit all the fuel pipes to the pump.

To Replace the Fuel Pump Gear

1. If necessary fit dowel into fuel pump gear.
2. Replace gear, locating dowel between gear and fuel pump.
3. Replace and secure washers and setscrews.
4. Refit idler gear, aligning all timing marks.

NOTE : *Please refer Appendix I for more detail.*

To Remove the Camshaft

1. Remove the rocker shaft assembly as previously described.
2. Remove the timing case cover as previously detailed.
3. Turn the crankshaft until all the timing marks are aligned.
4. Lift the tappets and remove the camshaft and gear from its location in the cylinder block taking care not to damage the journals, cams or tappets.

To Replace the Camshaft

1. Lift the tappets, and carefully fit the camshaft and gear continually turning the camshaft. Take care not to damage the journals, cams or tappets. Make sure the timing marks on the idler gear and camshaft are aligned correctly.
2. Replace timing case cover.
3. Refit the rocker shaft and reset the tappets.
4. Replace cylinder head cover.

Camshaft Thrust

The camshaft end float is taken up by a steel spring rivetted to the timing case front cover.

To Remove the Timing Case

1. Remove the timing case cover as previously detailed.
2. Release and remove the rocker shaft assembly.
3. Remove the sump as explained under “Lubricating System” (Section L).
4. Remove timing case bottom cover.
5. Unscrew the retaining setscrew and remove the locking washer, idler gear and spigot.
6. Lift the tappets and remove the camshaft, complete with its gear, taking care not to damage the cams or bearing journals.
7. Release the three setscrews and remove the driving gear from the fuel pump.
8. Remove all cables and pipes from the fuel injection pump. When removing the high pressure pipes from the pump, release the pipes at the atomiser end and remove the pipes.
9. Unscrew and release the three nuts, spring washers and flat washers securing the fuel pump flange to the timing case and remove the fuel injection pump. Ensure that all inlet and outlet connections of the fuel injection system are effectively sealed against the ingress of dust and dirt by the use of suitable caps and plugs.
10. Remove the setscrews and spring washers securing the timing case to the block and with a light tap remove the timing case from the cylinder block.

To Replace the Timing Case

1. For the purpose of correct location of the timing case, it is advisable to fit and fully locate the idler gear hub to the cylinder block.
2. Fit a new gasket to the cylinder block front face and replace the timing case.

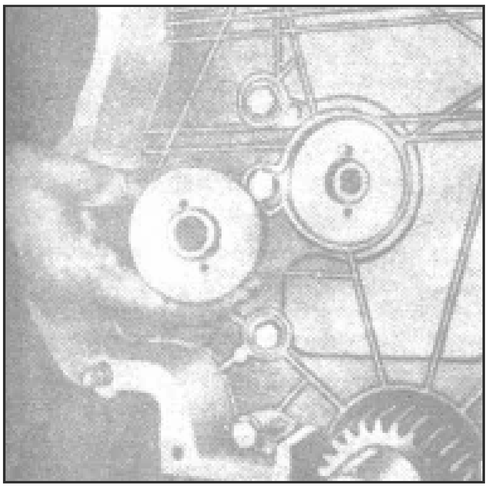


Fig. J. 3 Idler Gear Hub Location

3. Replace timing case bottom cover ensuring it is correctly aligned with the front face of the timing case.
4. Secure the fuel injection pump to the back of the timing case matching the scribed marks.
5. Turn the engine crankshaft until No. 1 piston is at top dead center (key on the front of the crankshaft vertifcally upwards)
6. Fit the fuel pump gear to the fuel pump, locating the dowel between the gear and pump.
7. Lift the tappets and replace the camshaft and its gear, turning the camshaft as it is being entered into the camshaft tunnel.
8. Replace the idler gear on its spigot, with the long tapered flange of the gear towards the cylinder block and the timing marks on the crankshaft gear, fuel pump gear, camshaft gear and idler in line.
9. Replace the sump as described in the “Lubricating System”.
10. Replace the timing case cover.
11. Refit all fuel pipes and controls.

Section K
Timing

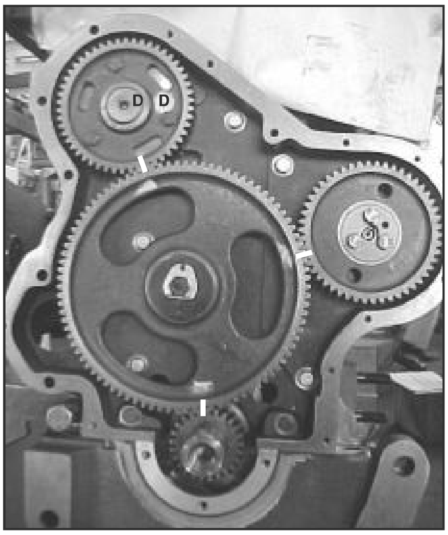


Fig. K.1 Timing Gears

The timing or the resetting of the timing can be simply and quickly carried out if the following instructions are kept in mind.

It is well to remember that the removal of the cylinder head does not in any way affect the timing of the engine.

Timing Marks

When the engine is timed at the factory, certain marks are stamped on the gears, so that if for any reason the timing must be distrubed, then the engine can easily be reset to it's original timing.

The method of marking is as follows:- With the engine timing correctly set, the engine is turned until No. 1 piston is at T.D.C. on its compression stroke. In this position, scribed lines or center punch marks are marked on the idler gear to correspond with lines or center punch marks on the camshaft, fuel pump and crankshaft gears respectively (Ref. Fig. Kl).

NOTE: *With all the timing marks aligned, the crankshaft will have to be turned 18 times before all the timing marks will align again.*

Fuel Injection Pump Timing Marks

On the fuel pump mounting flange is a scribed line which, when the fuel pump is fitted should coincide with a scribed line on the rear face of the timing case. Providing these scribed lines are in alignment and the fuel pump gear correctly fitted, then the fuel pump timing should be correct.

To Reset Engine Timing

Remove atomisers.

Bring No. 1 piston to T.D.C., No. 1 piston being on its compression stroke. The T.D.C. that has been obtained can be checked by examining the flywheel where the T.D.C. **mark should be central within the inspection opening, or the front of the crankshaft where the key for the fan belt pulley should be at the top of its periphery.**

Fit the camshaft gear ensuring the letter “D” stamped adjacent to one of the fixing holes is in alignment with the letter “D” stamped on the camshaft hub.

Fit the fuel pump gear. This is dowelled and will only go in one position.

Check that the fuel pump is correctly fitted to the engine with the scribed line on the mounting flange in line with the scribed line on the rear face of the timing case.

With the crankshaft gear fitted, **replace the Idler gear** ensuring the timing marks coincide (Ref. Fig. K.1).

After testing the engine, final adjustments may be necessary to find the perfect injection point. Adjustment may be made by releasing the fuel pump securing setscrews and turning the pump in the direction required.

To Check Valve Timing

Turn the engine until maximum lift is obtained on No. 3 cylinder exhaust valve.

In this position, set the clearance between rocker lever and No. 1 inlet valve to 0.031 inch (0.787 mm).

Now turn the engine in the normal direction of rotation until the tappet of No. 1 inlet valve just tightens.

At this point, No. 1 piston should be at T.D.C. This can be checked by examining the T.D.C. mark on the engine flywheel. The tolerance for valve timing is plus or minus $2^{1}/_{2}$°.

It should be noted that **no adjustment is provided for valve timing.** Provided the gear is correctly fitted to the camshaft (see previous remarks) then the timing can only be one or more teeth off.

When the timing is found to be correct, adjust the valve clearance to 0.012 inch (0.30 mm) cold.

Section L
Lubricating System

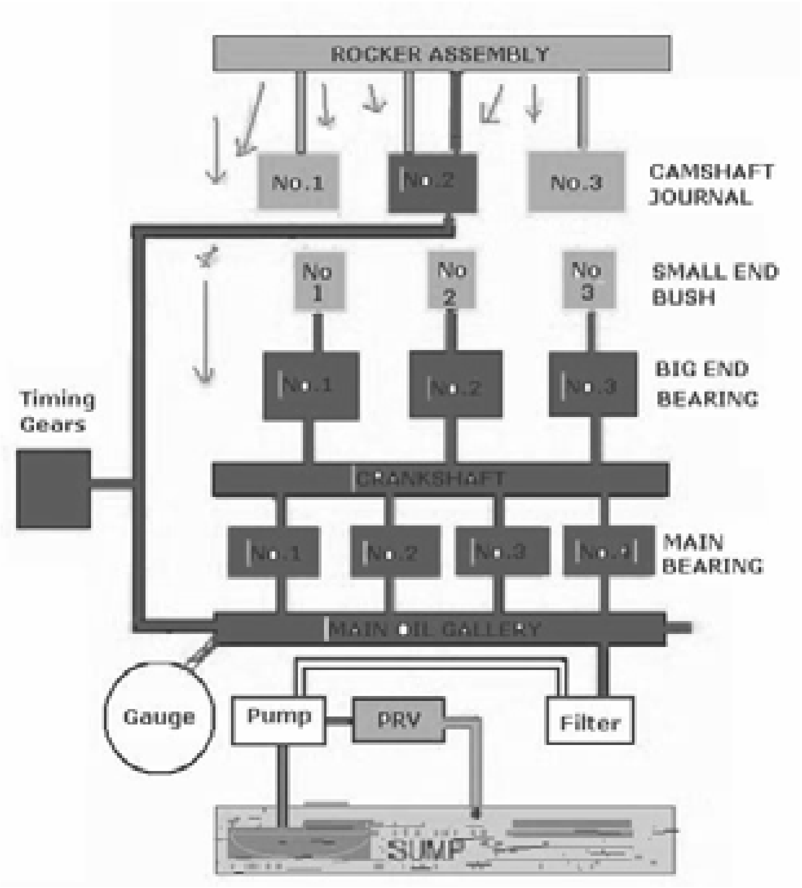

ROCKER ASSEMBLY
No.1
No.2
No.3
CAMSHAFT JOURNAL
No 1
No 2
No 3
SMALL END BUSH
No.1
No.2
No.3
BIG END BEARING
Timing Gears
CRANKSHAFT
No.1
No.2
No.3
No.4
MAIN BEARING
MAIN OIL GALLERY
Gauge
Pump
PRV
Filter
SUMP

Fig. L1 Engine Lubrication

NOTE : *Lubricating oil Data in Section Q.*

The importance of correct and clean lubrication cannot be stressed too highly and all references to engine oil should be taken to mean lubricating oil which falls within the specifications given in section Q. Care should be taken that the oil chosen is that specified for the climatic conditions under which the engine is operated.

The sump should be filled with a suitable lubricant to the correct level but do not attempt to overfill above the full mark. Before filling or checking the dipstick, ensure the application is on level ground.

Oil Circulation

The system of lubrication (Fig. L.1/ L.2) comprises pressure feed to main and big end bearings, camshaft bearings, rocker shaft and timing gear train.

The pump draws oil through the strainer (where fitted) from the sump and delivers it by a pipe inside the crank case through a drilling in the side of the cylinder block to the lubricating oil filter.

Oil passes through the filter and then through an internal drilling in the cylinder block to the pressure rail which is an internal passage within the crankcase.

Holes drilled in the crankcase webs feed oil from the pressure rail to the main bearings and holes in the crankshaft webs carry oil to the big end bearings. Surplus oil returns to the sump.

An oil seal prevents oil leaking along the crankshaft at the rear end and oil thrown from this seal returns to the sump.

The small end bushes are lubricated by splash and lubricating oil mist.

Running across the front of the cylinder block is an internal passage which connects with the pressure rail. The oil comes out from this passage on the camshaft side of the engine and is delivered along an external pipe to the lower drilling in the center camshaft bearing journal.

As the camshaft revolves, oil is picked up and carried round in the narrow slot machined on the center camshaft journal until it escapes through the upper drilling in the camshaft tunnel. The oil then flows through a pipe to the cylinder head whence another pipe conveys it to the hollow rocker shaft which feeds oil to the rocker lever bushes, etc.

It will be appreciated that due to the small capacity of the slot on the camshaft journal, only a reduced quantity of oil can pass to the rocker shaft during each revolution of the camshaft.

The overflow of oil from the rocker shaft flows from the cylinder head into the camshaft tunnel and from the front of the tunnel onto the timing gears and then returns to the sump.

Further lubrication for the timing gears is provided by means of a drilling in the block between the horizontal drilling referred previously and the idler gear spigot. Oil from this drilling escapes through a hole in the idler gear boss.

Oil Pressure

See that oil pressure is registered on the gauge.

The actual pressure may vary with individual engines but the oil pressure at maximum engine speed and normal working temperature should be 30-60 psi (2 - 4 bar).

There will be a pressure drop while idling and a slight decrease in normal working pressure when the engine is hot.

If the oil pressure as registered on the gauge is below normal, check the following in the order given below:

1. Dipstick. Ensure the sump oil level is up to the “full” mark.
2. Oil pressure gauge. Check for accuracy with master gauge.
3. Lubricating oil filter. May be choked. Renew element.
4. Sump strainer may be plugged. Remove, clean and replace.
5. Lubricating oil pump. Ensure that suction and delivery pipe unions are tight.
6. Oil pressure relief valve. Foreign matter may be preventing valve from closing.

Lubricating Oil Filters

The importance of using clean lubricating oil in the first place, and providing means to ensure that it is always clean in use, is hardly second to the importance of cleanliness in respect of the fuel.

It is imperative, therefore, that lubricating oil filters are not neglected.

To ensure cleanliness, filters are incorporated.

1. Oil Filler strainer.
2. Sump Strainer.
3. Main (full flow) filter.

The purpose of the oil fill strainer is to prevent large objects entering the sump when the engine is being filled with lubricating oil.

The sump strainer consists of a perforated container which is fitted over the suction pipe of the oil pump.

This strainer requires no special attention, but it should be cleaned anytime the sump is removed.

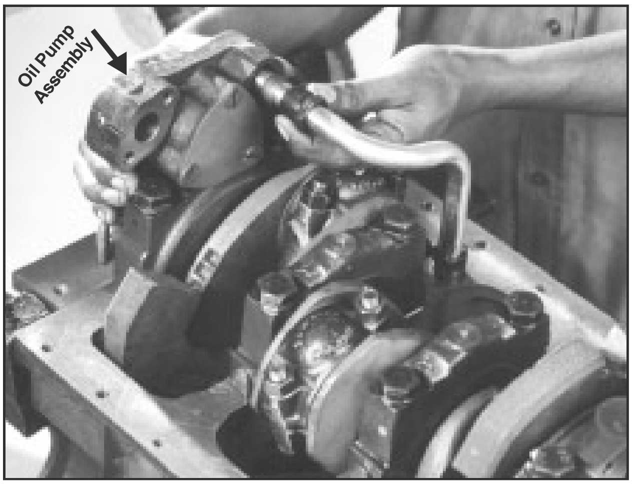


Fig. L.2 Oil Pump – Removal / Refitting

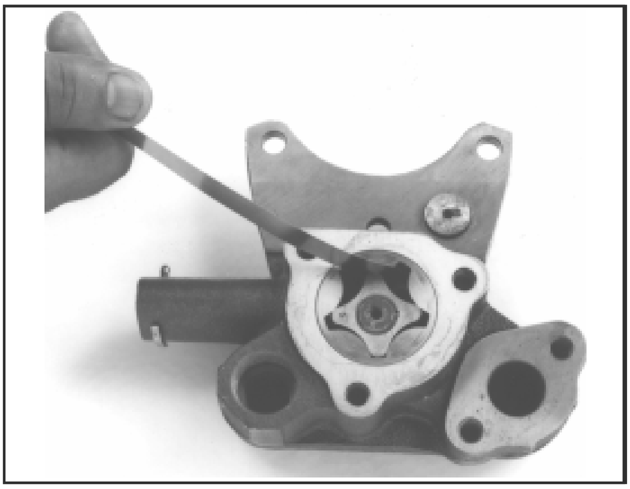


Fig. L.3 Checking Oil pump clearance (Inner rotor to Out rotor body)

Main (Full Flow) Filter

This filter incorporates either a separate paper element fitting in a filter bowl or a screw on canister where the element is integral with the canister. Both elements should be renewed not cleaned, at the appropriate time, as given in Section C.

To Renew the Canister:-

1. Unscrew and discard old oil canister.
2. Clean the filter head and the threaded adaptor.
3. Using clean engine lubricating oil, liberally oil the top seal of the replacement canister.
4. Fill the new canister with clean lubricating oil, allowing time for the oil to filter, through the element. Screw the replacement canister on to the filter head until the seal just touches the head and then tighten by hand as detailed in the instructions on the canister. Where a tool is available, tighten to 15 lbf. ft. (20 Nm.).
5. Run the engine and check for leaks. Check the oil level after running and top up as necessary.

Paper Element Replacement (Early Type) :-

1. Unscrew the center bolt at end of cover.
2. Drop filter bowl clear.
3. Remove element and discard.
4. Before replacing new element, clean inside of filter bowl with cleaning fluid.
5. Ensure that the rubber joints are in good condition, if not, replace by new.
6. Start engine and check for leaks. Check oil level after running and top up as necessary.

The bolt securing the filter bowl should be checked for tightness after the first 25 hours of running.

Oil Pressure Relief Valve

The oil relief valve which is located in the oil pump body prevents the pressure becoming excessive as might otherwise happen when the oil is cold.

The relief valve comprises a spring loaded plunger.

When the predetermined pressure setting is exceeded, the valve opens and some of the oil is released, to return to the sump. That continues until the oil warms up and flows at the desired pressure. The valve then closes.

When to replace the Oil

The oil in the sump must be drained in accordance with preventive maintenance, Section C, and replaced by clean new oil of a specification suitable for the climate (Section Q)

To Remove Sump

Remove drain plug and drain off oil.

Remove dipstick.

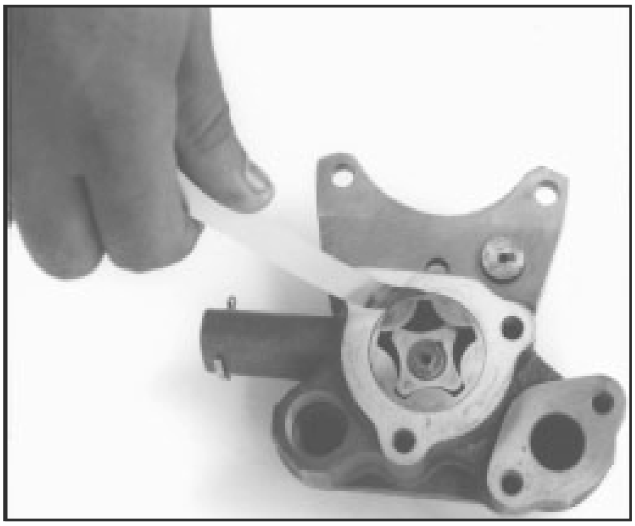


Fig. L.4 Checking Oil pump clearance (Outer rotor to body)

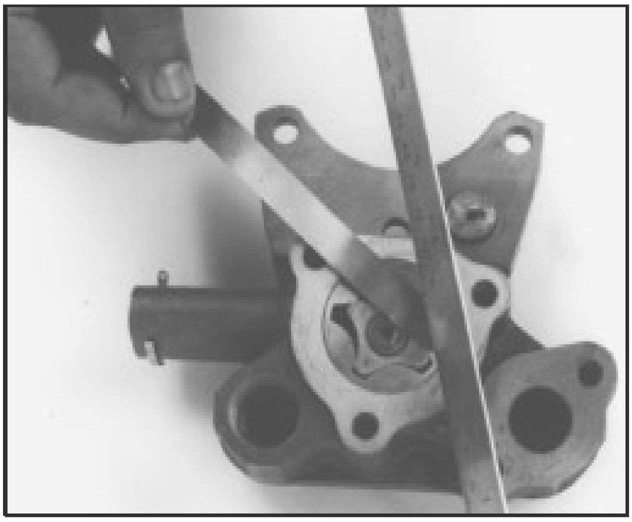


Fig. L.5 Checking Oil pump clearance (Top of rotors to body)

Where necessary, remove setscrews securing rear of sump to flywheel housing.

Remove all setscrews securing sump to crankcase and lower sump.

To Replace sump

Remove all traces of old joints and cork strips from timing case bottom cover and rear main bearing cap.

Lightly smear crankcase faces with a thin coating of jointing compound and place seals in position ensuring all holes lined up.

When placing seals in position, it is important that the mitred ends go right up into the recesses of the timing case bottom cover and rear main bearing cap.

Lightly coat cork joints with jointing compound and place in the grooves provided in the timing case bottom cover and rear main bearing cap.

Place sump in position and screw setscrews lightly home.

Where applicable, replace setscrews securing rear of sump to flywheel housing.

Tighten setscrews securing sump to crankcase.

Replace dipstick and sump drain plug.

Pour oil in the sump and ensure oil level is up to the “full” mark on dipstick.

To Remove Oil Pump

Remove sump (see previous heading). Remove the three setscrews at the bottom of the timing case front cover and the two nuts at the bottom of the timing case when the timing case bottom half can be removed.

Disconnect the delivery pipe from the oil pump to cylinder block.

Remove circlip and move oil pump idler gear forward.

Unscrew the three setscrews securing the oil pump to the front main bearing cap and remove oil pump. (Fig. L2)

To dismantle Oil Pump

Remove suction and delivery pipes.

Remove oil pump idler gear.

Using a special screw driver, unscrew the three screws and remove the pump end plate.

The outer rotor can then be removed.

The oil relief valve is located in the body of the lubricating oil pump. It is an adjustable valve but unless special test equipment is available, no attempt should be made to dismantle it. The relief pressure is set and adjusted before the engine leaves the factory.

Inspection

The clearances for new pumps are given in Section B.

1. Thoroughly clean all parts and inspect the rotors for cracks or scores.
2. Install the driven rotor in the pump body making sure the chamfered edge of the outer rotor enters the pump body first. Check the clearance between the maximum diameter of the inner rotor and the minimum diameter of the outer rotor at all points (Fig. L3).
3. Check the clearance between the outer rotor and the pump body. (Fig. L4)
4. Check the clearance between the top of the rotors and the end of the pump body with feeler gauges and straight edge. (Fig. L 5).

NOTE: *Should an oil pump be worn to such an extent it adversely affects the working oil pressure then a replacement pump should be obtained. The component parts of the oil pump are not supplied individually therefore if any parts require replacing a replacement assembly should be fitted.*

To Re-assemble the Oil pump

Replace outer rotor, inner rotor and shaft in oil pump body.

Replace end cover and secure with three screws.

Press on driven gear and ensure pump rotates freely.

Replace idler gear and circlip

Prime lub oil pump with oil before fitting.

To Refit Oil Pump

Fit oil Pump to front main bearing cap and secure with three setscrews.

Secure idler gear with circlip.

Replace suction and delivery pipes to and from oil pump.

Replace timing case bottom half and secure with two nuts and washers to timing case top half.

Replace the two setscrews and nut at the bottom of the timing case front cover.

Replace sump in accordance with previous instructions.

Before starting, the engine should be turned over while operating the stop control, until oil pressure is registered.

Section M
Cooling Systems

The cooling coolant is circulated by a centrifugal type pump which is mounted on the front of the timing case cover. It is driven by a V-belt from the engine crankshaft and provision is made for fitting a fan on the front end of the water pump pulley.

The pump does not require greasing as the bearings are treated with a special quality grease before assembly.

Fan Belt Adjustment

Belt tension should be adjusted so that, without undue pressure, the belt can be depressed approximately 3/8 in. (10 mm) with the thumb applying pressure at a point midway between the water pump and alternator pulley (Refer Fig. M5)

Adjustment of the belt tension is achieved by altering the position of the alternator. Release the alternator adjusting link and support bracket bolts. Move the alternator to give the correct tension and then tighten the bolts and re-check the tension.

When a new belt has been fitted it is advisable to check the belt tension after a few hours running to ensure that no initial stretching has occurred.

To Remove Water Pump

Remove Fan.

Loosen alternator securing setscrews and remove fan belt.

Remove water pump inlet and outlet hose connections.

Unscrew setscrews securing the water pump and remove.

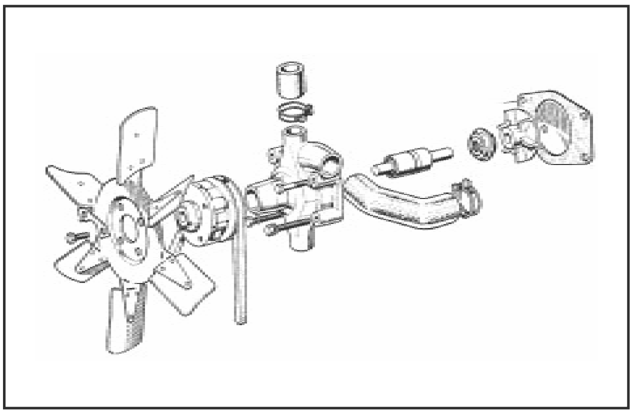


Fig. M 1 – Water pump exploded view

To Dismantle Water Pump

Remove the water pump pulley using a suitable tool. The tapped holes in the pulley can be utilised for this purpose (Ref. Fig. M2).

Press the water pump shaft complete with bearings and impeller from out of the rear of the pump body. Press the shaft and bearing assembly out of the impelier.

Remove the unitised seal from the shaft.

The shaft and bearings are manufactured as one component and cannot be dismantled.

To Re-assemble Water Pump

With the shorter end foremost, press the shaft and bearing assembly into the rear of the water pump body until the bearing housing end is flush with the front of the water pump body.

Fit the unitised seal.

Supporting the shaft at the front end, press the impeller with blades inwards onto the rear of the shaft until a dimension of 0.010 inch (0. 25 mm) to 0.020 inch (0. 51 mm) is obtained between the blades of the impeller and the pump body (Ref. Fig. M3)

Spin the assembly to ensure freedom of rotation.

Replace the four setscrews (used for securing the water pump onto the timing case cover) before pressing pulley on shaft.

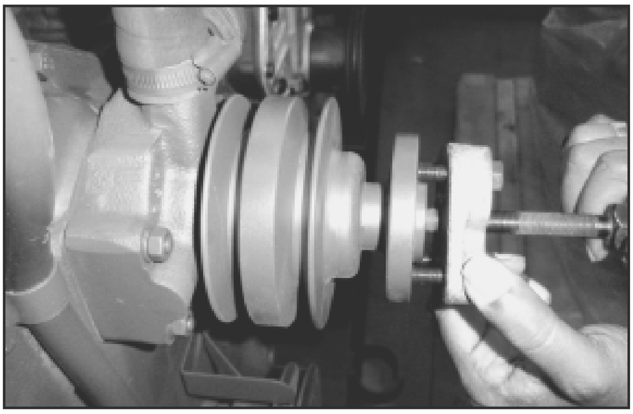


Fig. M 2 – Water pump pulley removal (Twin groove)

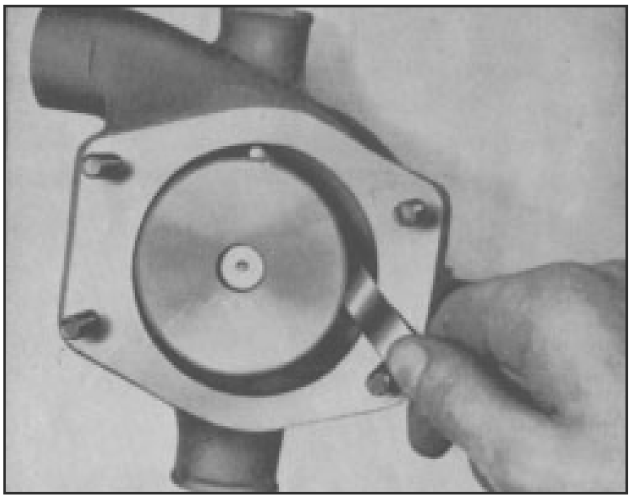


Fig. M 3 – Checking impeller clearance

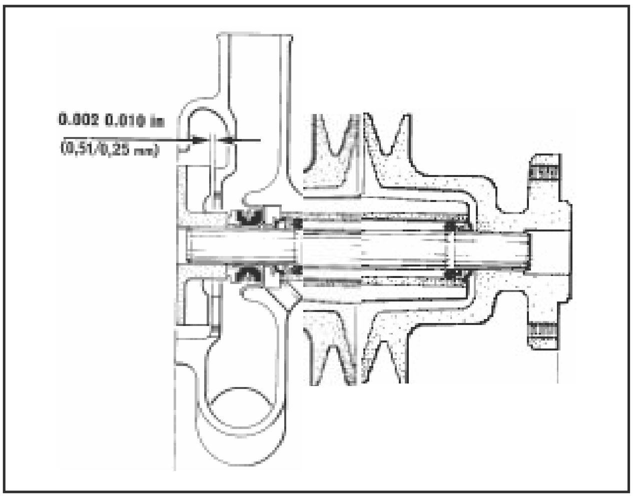


Fig. M 4 – Water pump cut section

Supporting the shaft at the impeller end, press on the water pump pulley until the front end of the fan mounting face is 5.531 in (140.49 mm) from the rear face of the pump body (Ref. Fig. M4).

Recheck the clearance between the impeller blades and pump body, and spin the assembly to ensure freedom of movement.

To Re-fit Water Pump to Engine

Fit new water pump joint, using jointing compound.

Connect up water pump inlet and outlet hose connections.

Replace fan belt and tension.

Replace fan.

Thermostat

A thermostat is fitted in the cylinder head coolant outlet to assist in providing a shorter warming up period for the engine. The thermostat can be removed after the coolant outlet connection and joint have been removed. When refitting the thermostat, ensure that the jiggle pin (if provided) in the top of the thermostat is free to move in its location.

To check the thermostat, suspend it in coolant and heat gradually. With a thermometer, check that the thermostat operates at the temperatures given in Section B. If it is faulty, it should be replaced - no attempt should be made to adjust a faulty thermostat.

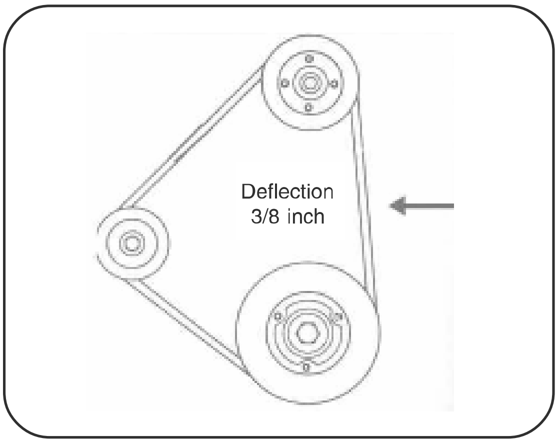


Fig. M 5 – Checking Belt Tension

Section N

Fuel System and Air Cleaners

The principal components of the equipment for delivering the fuel oil to the engine are as follows:

Filters

Fuel Lift Pump (when fitted).

Fuel Injection Pump

Atomisers

So accurate is the manufacture of the fuel injection equipment that the importance of cleanliness when handling fuel cannot be over stressed.

Adequate filters are provided in the system, but much can be done by the operator to ensure that the equipment is maintained in first class condition.

All fuel used must conform to :-

BRITISH STANDARD No. BS. 2869: 1970 CLASS A or I.S: 1460/2000 Grade special or Grade A and must be clean, free from coolant, suspended dirt and other foreign matter. Filtering of fuel before it enters the tank will help, and regular filter changing will ensure that only perfectly clean fuel reaches the fuel injection pump.

Given these conditions, ninety per cent, at least of potential engine troubles would be eliminated. Attention is on that account earnestly directed towards the section of this manual which refers to the care and upkeep of filtering apparatus.

In a pressure fed system, the lift pump lifts the fuel from the tank via the pre-filter (fitted) and then passes it through the dual filter to the fuel injection pump, which delivers it in measured quantities and at appropriate intervals, to the atomisers (Ref. Fig. N1)

Where no lift pump is fitted, i.e. in a gravity fed fuel system, fuel flows from the tank, through a pre-filter, to the dual filter. From there, filtered fuel enters the injection pump which delivers it to the atomisers.

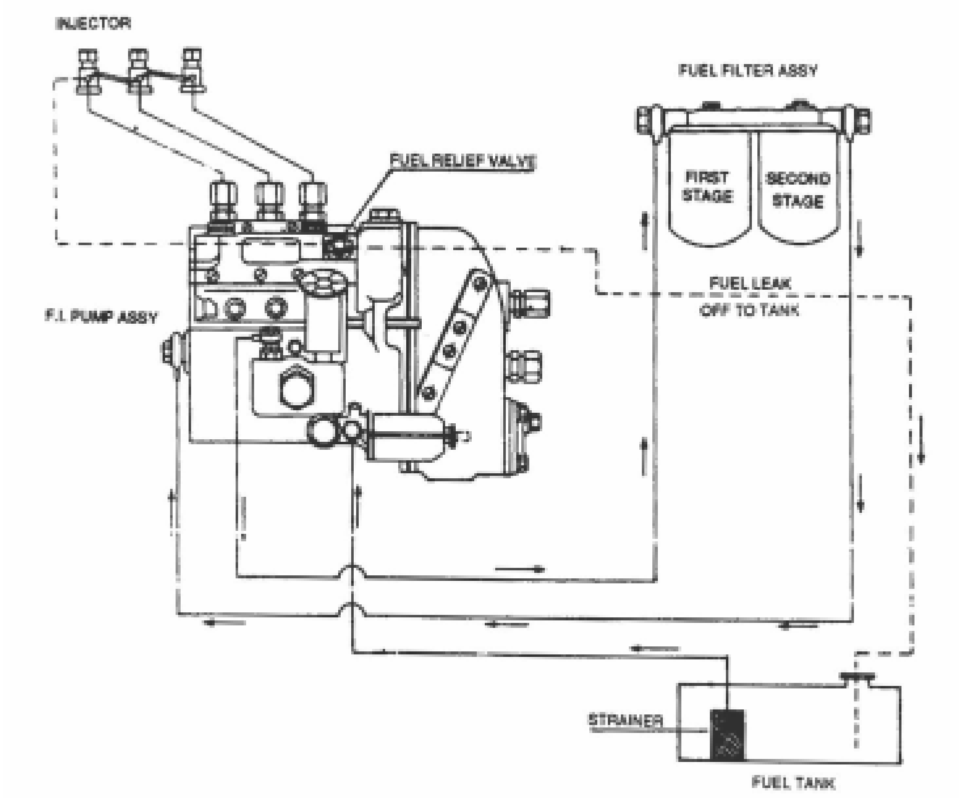


Fig N1 Fuel Pipe Layout (Pressure Feed System)

Fuel Lift Pump (Pressure Feed System Only)

The lift pump is of the plunger type and is driven by a cam on the camshaft of the fuel injection pump, on the side of which it is fitted.

A hand primer is fitted for use if the supply of fuel from the tank has at any time failed, and for bleeding.

The fuel pump is an instrument of precision. Its working parts are made to extremely fine limits and mishandling in any shape or form, or the entry of the smallest particle of dirt into its working parts may damage it and diminish its accuracy of operation. Hence the importance of ensuring that the fuel is thoroughly filtered before it reaches the pump.

When requesting information regarding the fuel pump, the type and number should be quoted. This can be obtained from a plate fitted to the pump gallery above the inspection plate.

Fuel Pipes

No two pressure pipes from the fuel pump to the atomisers are alike. Keep this in mind when replacing.

Examine the nipples which will be found on each end of these pipes.

If the union nuts at any time have been over-tightened, the nipples may have been damaged. If so, leakage will result and the complete fuel pipe will have to be replaced.

In this connection, bear in mind that the working pressure which these joints must sustain is several thousand pounds per square inch. Only a perfect joint is satisfactory.

Assemble the pipe to the fuel pump and atomiser unions to check that the pipe fits square at both ends. Do not fit one end and then bend the pipe to square it with the other union.

When fitting the pipe, tighten the unions alternately a little at a time, first one end and then the other.

If the pipe is square to the unions at each end as described above, no force will be needed to make a good joint. No force should be used.

Use only a standard open ended spanner.

If the union is tightened excessively, the nipple may be damaged. The same danger exists if the pipe is not square to and central with the union.

When changing an atomiser, always remove the pipe entirely. Never undo only one end leaving the other tight. Never bend the pipe.

Atomisers

Each atomiser consists of a steel body, held to the cylinder head by means of a flange and two studs.

The joint between the atomiser and cylinder head is made by a special copper washer between the lower face of the nozzle cap nut and the recess in the cylinder head.

When preparing to fit the atomiser in its place in the cylinder head, care should be taken that only special type of copper washer is used to make this joint. The recess in the cylinder head, the faces of the copper washer and the corresponding face on the nozzle holder cap nut should be perfectly clean if a leakproof joint is to result.

It is advisable to fit a new joint washer when the atomiser is replaced, after having been removed for any reason.

Ensure that the old washer has been removed from the cylinder head or atomiser.

This joint washer should be an easy, but not loose fit for the atomiser nozzle and it is because this is such an important feature that only washers specially made for this purpose should be used and none other. On no account should ordinary spark plug type washers be used.

The atomiser can now be fitted in place, care being taken to see that it is an easy fit in the cylinder head and on the hold down studs, so that it can be placed down on the copper joint without force of any kind. The nuts on the flange should then be tightened down evenly in order to prevent the atomiser nozzle from binding and being damaged in the cylinder head. This is very important since any unevenness in tightening down may cause distortion of the atomiser nozzle resulting in its failure and will most certainly result in blowby.

NOTE : *In S325.3 engine, only one stud with nut and bracket is being used to retain the atomiser (P-Type) in position on cylinder head.*

Maintenance

Atomisers should be taken out for examination at regular intervals. How long this interval should be is difficult to advise, because of the different conditions underwhich engines operate.

When combustion conditions in the engine are good and the fuel tank and filtering system are maintained in first class order, it is often sufficient if the atomisers are tested at lengthy intervals. For details refer to Maintenance Section C.

It is no use taking atomisers out for attention unless an atomiser testing pump is available or spare atomisers are at hand for substitution.

The nearer the ideals of good fitting with adequate cooling and absolutely clean fuel are realised, the less attention the atomisers will need and so the longer their efficient life. In this connection, since there is no other item upon which the performance of the engine depends so much, it pays the user handsomely to see that the engine never runs with any of its atomisers out of order.

Troubles in Service

The first symptoms of atomiser trouble usually fall under one or more of the following headings:

1. Misfiring.
2. Knocking in one (or more) cylinders.
3. Engine overheating.
4. Loss of power.
5. Smoky exhaust (black).
6. Increased fuel consumption.

Often the particular atomiser or atomisers causing trouble may be determined by releasing the pipe union nut on each atomiser in turn, with the engine running at a approximate 1200 RPM. This will prevent fuel being pumped through the nozzle to the engine cylinder, thereby altering the engine revolutions. If after loosening a pipe union nut, the engine revolutions remain constant, this denotes a faulty atomiser.

After stopping the engine the nuts from the flange of the doubtful atomiser should be removed and the complete unit withdrawn from the cylinder head and test using a atomiser/nozzle tester and/or have tested by a authorized fuel pump station.

Atomiser Pressures

No attempt should be made to service or reset, the pressure of an atomiser unless the proper equipment is available.

When renewing atomisers, reference should be made to the appropriate Parts list to ensure fitment of the correct type.

Air Cleaners

The time period for cleaning the air cleaner depends on operating conditions. Therefore under extremely dusty conditions, the time limit recommended for cleaning should be decreased.

The correct maintenance of the cleaner will greatly assist in extending the life of the engine.

Dry type air cleaner / Maintenance

The dry type air cleaner is provided with paper elements. The elements are not to be removed or cleaned or tapped but should be replaced whenever the element is found plugged which would be identified by restriction indicator or by loss of power or speed drop or emission of black smoke from the exhaust.

A dust collecting bowl is provided at one end of air cleaner. The dust collected in the bowl must be emptied at the end of each day's operation initially. Depending upon the field conditions and the amount of dust collected, the frequency of emptying the above bowl can be altered. The element is to be replaced every 250 hrs.

It should be ensured that the hose connections, metal pipe connections and their clips between the air cleaner outlet and the inlet of air inlet manifold of the engine are secured and are airtight.

Care should be taken to see that no unfiltered air enters the system through these connections.

Section O Fuel injection pump calibration chart

Fuel injection pump calibration chart :

REFERENCE NO : STS-TS-PER 2.5 n1

Edition : 11.2006
Replaces(edition) : 05.2004
Test oil : F 002 S3E 001
Revision : 2
Combination No. : F 002 A0Z 451-E 040 173 3 000
Injection pump : PES 3 A 80 D 320 RS 2000
Governor : RSV 375...1000 A4 C 1410 R

Customer : Simpson & Co. Ltd.
Engine model : S325.3 US Tier-II
Engine code : 65200
Application : Tractor

TEST BENCH REQUIREMENTS

Test oil inlet temperature : 38°-42°C
Overflow valve : F002A10627
Inlet pressure in bar : 1.5
Test injector : 0681343009
Opening pressure in bar : 172.0-175.0
High pressure pipe (ODXIDxlength) in mm : 6X2X600

(A) CALIBRATION OF PUMP WITHOUT GOVERNOR ACTION

Direction of rotation : Clockwise
Prestroke in mm : 1.95-2.05 (1.9–2.1)
Control rack position in mm : 18.0–21.0
Cam sequence : 1-2-3
Cam displacement : 0-120–240° ±0.5°
Tappet clearance in mm : min 0.2
Injection Timing locking : -

BASIC SETTING

Speed-min -1 (rpm) : 1000
Control rack travel in mm : 12.95–13.05
Delivery quantity(x) : 5.75–6.05 in cm^3/ 100 strokes
Maximum spread in cm^3 : 0.3 (0.4)
Speed-min -1 (rpm) : 375
Control rack travel in mm : 4.9-5.1
Delivery quantity(x) : 0.65–0.95 (0.45–1.15) in cm/100 strokes
Maximum spread in cm^3 : 0.4 (0.6)

(B) ADJUSTMENT OF PUMP AND GOVERNOR GUIDE SLEEVE TRAVEL

Control lever position : Free
Speed-min -1 (rpm) : 800
Control rack travel in mm : 0.3-0.7

1. MAXIMUM SPEED CONTROL (RATED SPEED) (without supplementry idling spring)

Control lever position : 59.0±4.0°
Speed-min -1 (rpm) : –
Boost pressure in bar : –
Control rack travel in mm : –
Speed-min -1 (rpm) : 1000
Boost pressure in bar : –
Control rack travel in mm : 12.95 – 13.05
Speed-min -1 (rpm) : 1040 – 1050
Boost pressure in bar : –
Control rack travel in mm : 12.0
Speed-min -1 (rpm) : 1075–1095
Boost pressure in bar : –
Control rack travel in mm : 4.0
Speed-min -1 (rpm) : 1250
Boost pressure in bar : –
Control rack travel in mm : 0.3-1.4

2. FULL LOAD DELIVERY

Speed-min -1 (rpm) : 1000
Boost pressure in bar : –
Control rack travel in mm : 12.95 – 13.05
Delivery quantity(x) : 29.25 – 29.75 (28.5 – 30.5) in cm^3/500 strokes
Maximum spread in cm^3 : 1.3(2.0)

3. TORQUE CONTROL

Speed-min -1 (rpm) : –
Boost pressure in bar : –
Control rack travel in mm : –
Speed-min -1 (rpm) : –
Boost pressure in bar : –
Control rack travel in mm : –
Speed-min -1 (rpm) : –
Boost pressure in bar : –
Control rack travel in mm : –
Speed-min -1 (rpm) : –
Boost pressure in bar : –
Control rack travel in mm : –
Speed-min -1 (rpm) : –
Boost pressure in bar : –
Control rack travel in mm : –
Speed-min -1 (rpm) : –
Boost pressure in bar : –
Control rack travel in mm : –

4. COURSE OF DELIVERY

Speed-min -1 (rpm) : 600
Boost pressure in bar : –
Delivery quantity(x) : 24.75–26.25
(24.0 –27.0)
in cm^3/500 strokes
Maximum spread in cm^3 : 1.8(3.5)
Speed-min -1 (rpm) : 800
Boost pressure in bar : –
Delivery quantity(x) : 26.25–27.75
(25.5–28.5)
in cm^3/500 strokes
Maximum spread in cm^3 : 1.8(3.5)
Speed-min -1 (rpm) : –
Boost pressure in bar : –
Delivery quantity(x) : –
in cm^3/500 strokes
Maximum spread in cm^3 : –
Speed-min -1 (rpm) : –
Control rack travel in mm : –
Delivery quantity(x) : –
in cm^3/500 strokes
Maximum spread in cm^3 : –

5. IDLING SPEED CONTROL (RATED SPEED)

Control lever position : 26.0±4.0°
Speed-min -1 (rpm) : 375
Control rack travel in mm : 4.9–5.1
Speed-min -1 (rpm) : 100
Control rack travel in mm : Minimum 19.0
Speed-min -1 (rpm) : 375
Control rack travel in mm : 4.9–5.1
Speed-min -1 (rpm) : 460–520
Control rack travel in mm : 2.0

6. MAXIMUM SPEED CONTROL (RATED SPEED)

(with supplementary idling spring)
Speed-min -1 (rpm) : –
Control rack travel in mm : –

7. GOVERNOR CUTTING IN SPEED

Speed-min -1 (rpm) : 1040-1050
Boost pressure in bar : –
Control rack travel in mm : 12.0

While over checking ,if the cutting speed is above the rated speed and if,the delivery values are within the overchecking tolerance control rack remains at full load position even at 50 min (rpm) less than the rated speed the cutting-in speed should be declared OK.

8. DEGREE OF IRREGULARY

Speed-min -1 (rpm) : 1085–1115
Boost pressure in bar : –
Control rack travel in mm : 4.0”
No of notches : 17.0

9. STARTING TRAVEL

Speed-min -1 (rpm) : –
Control rack travel in mm : –
Delivery quantity(x) : –
in cm^3/500 strokes

10. STARTING FUEL DELIVERY

Speed-min -1 (rpm) : 100
Control rack travel in mm : 13.25–13.75
Delivery quantity(x) : –
in cm^3/100 strokes

Note:

1. Sl.No.of the operations indicate the sequence of operations. 3.(x):Average of the cylinders
2. Values given in brackets are overchecking values

Applicable only for BOSCH and MICO Test benches

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Section P

Flywheel and Flywheel Housing

Alignment of the Flywheel Housing and Flywheel

It is most important that the flywheel housing be correctly aligned with the crankshaft. Misalignment may give rise to difficulty in changing gear, etc. If the housing has been removed, as is necessary for a complete overhaul, the greatest care must be taken on replacement to ensure accuracy of alignment. The appropriate procedure is as follows:-

See that the face of both the rear of the cylinder block and flywheel housing are perfectly clean and free from burrs.

Set the housing on to the studs and tighten, but not oversight so as to allow adjustment.

Alignment of the Flywheel Housing Bore

Secure the base of a dial gauge to the flange of the crankshaft.

Set the needle of the gauge to the inside of the bored hole in the flywheel housing.

Turn the crankshaft and check that this is truly central. The housing is adjusted until it is central.

For convenience in turning the engine it is advisable to release (but not remove) the nuts holding the atomisers in place.

The flywheel housing bore should be truly central with the crankshaft within the limits given in the table (total indicator reading).

Alignment of the Flywheel Housing Face

With the face of the "dial gauge" still bolted to the crankshaft flange, adjust the "dial" so as to set the needle against the vertical machined face of the flywheel housing, and, again turning the crankshaft, check that this face is perpendicular to the crankshaft axis. When carrying out this check, the crankshaft should be pressed forward to take up end float. This facing should be within the limits given in the table (total indicator reading) of being truly at right angles to the crankshaft axis.

All adjustments to bring the flywheel housing within the limits must be on the flywheel housing and under NO CONDITIONS must the rear of the cylinder block be interfered with.

When the housing is properly aligned to the above limits, tighten the securing nuts evenly.

Ream the dowel holes and fit the correct length and size dowels.

Fitting Flywheel and Checking Alignment

With the flywheel and crankshaft flange perfectly clean and free from burrs and with two suitable guide studs fitted in the crankshaft flange, position the flywheel on the crankshaft.

Insert the setscrews complete with locking plates into the flywheel holes and tighten evenly.

Secure the base of the dial gauge to the flywheel housing. With the flywheel at top center, set the needle of the gauge on the periphery at T.D.C.

Turn the crankshaft and check the dial, the flywheel should run truly within 0.012 inch (0.30mm) [total indicator reading].

With the base of the dial gauge still bolted to the flywheel housing, adjust the clock so as to set the needle against the vertical machined face of the flywheel.

Again turn the crankshaft and check the dial. The flywheel should be truly at right angles to the crankshaft axis within the limit of 0.001 inch (0,025 mm) per inch (25.4 mm) of flywheel radius from the crankshaft axis to the clock gauge plunger (total indicator reading).

When the flywheel has been checked for correct alignment, lock setscrews with locking plates.

Finally grease the spigot ball race if fitted.

LIMITS FOR FLYWHEEL /HOUSING ALIGNMENT

Housing Dia		
Up to to 14 $^1/_4$ inch (362 mm)	....	0.006 inch (0.15 mm)
Over 14 $^1/_4$ inch (362 mm) to 20 $^1/_8$ inch (511 mm)	....	0.008 inch (0.20 mm)
Over 20 $^1/_8$ inch (511 rnm) to 25 $^1/_2$ inch (648 mm)	....	0.010 inch (0.25 mm)
Over 25 $^1/_2$ inch (648 mm) to 31 inch (789 mm)	....	0.012 inch (0.30 mm)

SECTION Q

LUBRICATING OIL SPECIFICATION

Use only a good quality lubricating oil to the relevant specification as shown in the table below.

Attention : The type of lubricating oil to be used may be affected by the quality of the fuel which is available.

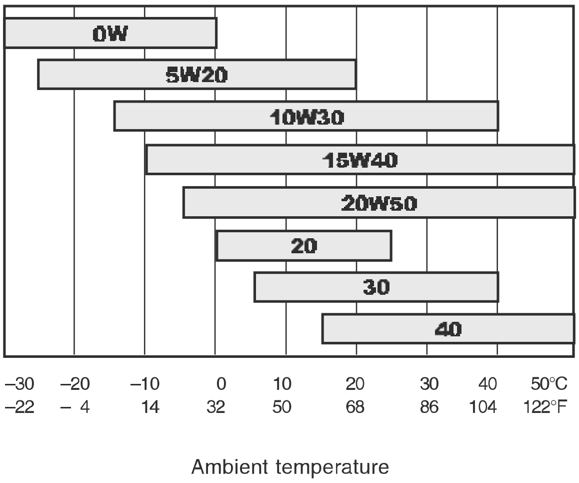
Always ensure that the correct viscosity grade of lubricating oil is used for the ambient temperature range in which the engine will run as shown in the chart below.

Lubricating oil specification

Engine Type	Specifications	
	API CCSE	API CDSE MIL-L-2104C CCMC D4
Naturally aspirated.	l	l (1)
Naturally aspirated engines in heavy duty earthmoving equipment.		l
Turbocharged.		l

(1) Not recommended for the first 25 / 50 hours of operation, nor for light load applications.

Recommended SAE viscosity grades



FUEL SPECIFICATION

To get the correct power and performance from your engine, use good quality fuel. The recommended fuel specification for S 325.3 engines is indicated below :

Cetane number : 45 minimum
Sulphur : 0.2% of mass, maximum
Viscosity : 2.5/4.5 centistokes at 40°C
Distillation : 86% at 350°C
Density : 0.835 / 0.855 kg/litre

Cetane Number :

Indicates ignition performance. A fuel with a low cetane number can cause cold start problems and affect combustion.

Viscosity :

Is the resistance to flow and engine performance can be affected if it is outside the limits.

Density :

A lower density reduces engine power, a higher density increases engine power and exhaust smoke.

Sulphur :

A high sulphur content can cause engine wear. Where only high sulphur fuels are available, it is necessary to use a highly alkaline lubricating oil in the engine or to renew the lubricating oil more frequently.

Distillation :

This is an indication of the mixture of different hydrocarbons in the fuel. A high ratio of light-weight hydrocarbons can affect the combustion characteristics.

Low temperature fuels :

Special winter fuels may be available for engine operation at temperatures below 0°C (32 °F). These fuels have a lower viscosity and also limit the wax formation in the fuel at low temperatures. If was formation occurs, this could stop the fuel flow through the filter.

APPENDIX I

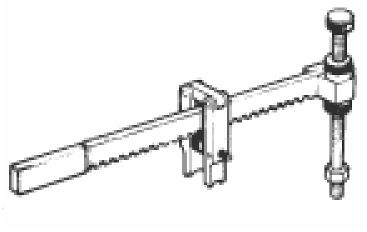
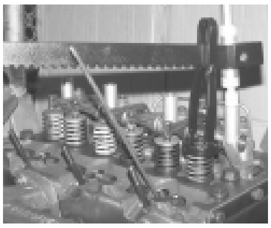
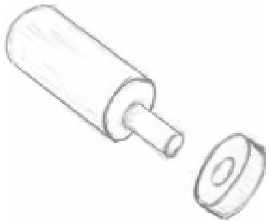
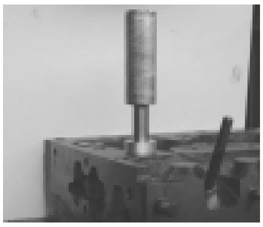
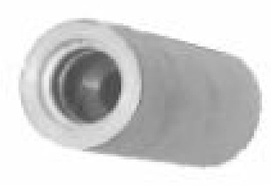
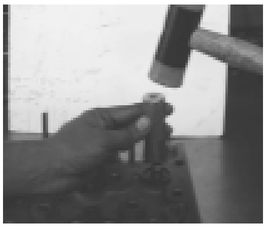
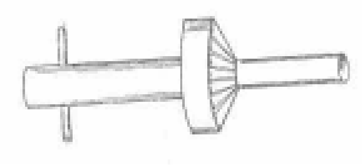
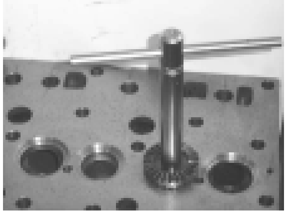
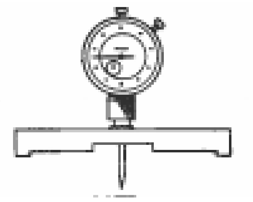
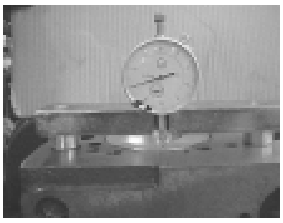
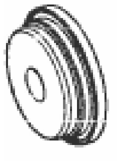
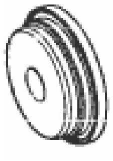
ILLUSTRATION	DESCRIPTION	TOOL NUMBER& APPLCATION
	Cylinder head valve spring compressor with adaptor	 SER 285
	Valve guide remover and replacer (Make use of screw or arbor press)	 SER 286
	Valve stem seal replacer	 SER 287
	Valve seat cutter	 SER 294
	Piston height and valve depth gauge	 SER 349
 Replacer  Remover	Cylinder liner remover/replacer adaptors suitable for liners of 3.6 inch dia. (Make use of hydraulic press)	SER 295

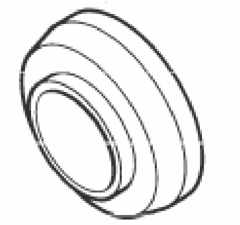
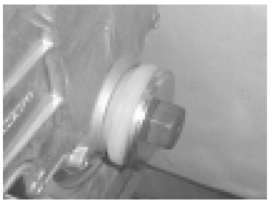
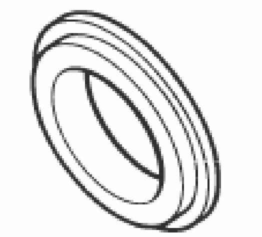
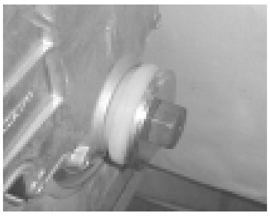
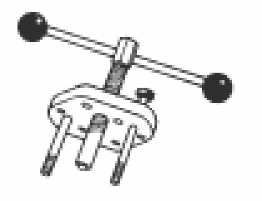
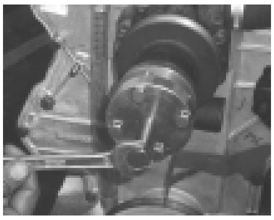
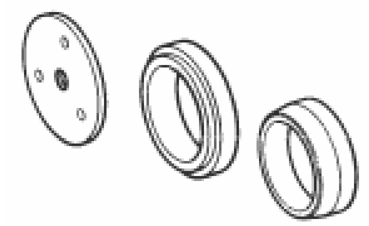
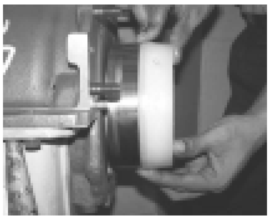
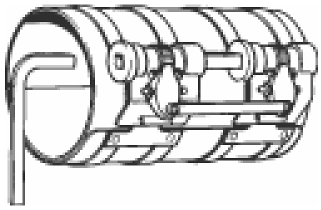
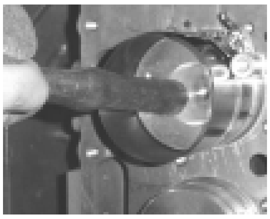
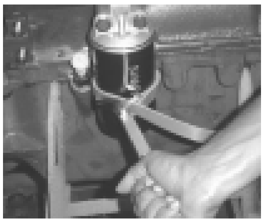
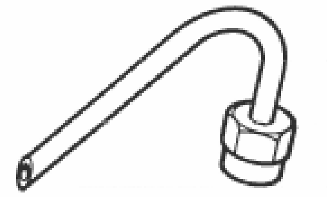
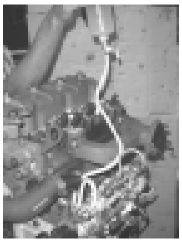
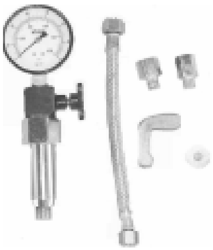
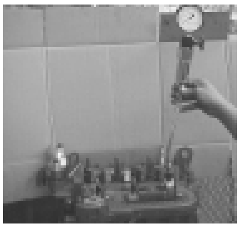
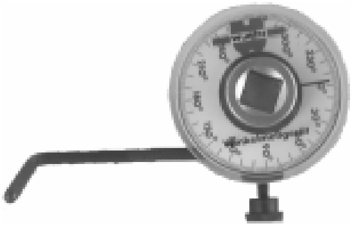
ILLUSTRATION	DESCRIPTION	TOOL NUMBER & APPLICATION
	Timing cover centraliser	 SER 290
	Timing cover oil seal replacer	 SER 291
	Basic puller	 SER 344
	Crankshaft rear end oil seal replacer (Lip type oil seal)	 SER 343
	Piston ring compressor	 SER 348
	Oil filter remover	 SER 347

ILLUSTRATION	DESCRIPTION	TOOL NUMBER & APPLICATION
	**Used for checking pump timing :** (Applicable for In-line pump) Fuel pump spill pipe supplied with gravity tank, connecting banjo and pipe (Used for checking spill timing)	 SER 289
	Compressor tester	 SER 285
	Angle gauge	 SER 292

SECTION 6

PART B

ENGINE SJ 327 E

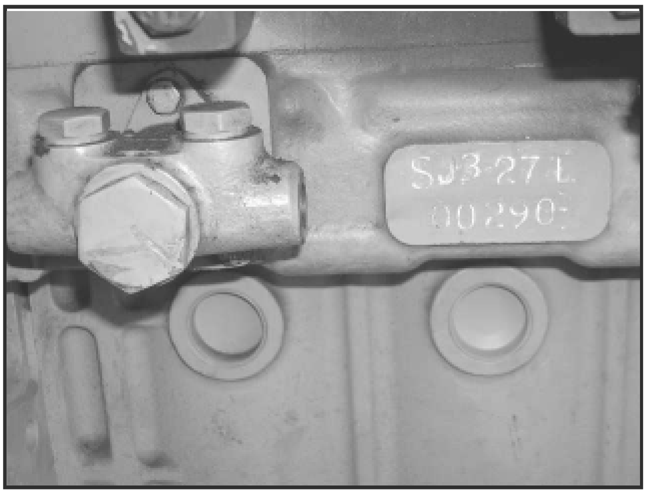
CONTENTS

Section	Description		Page No.
A	ENGINE NUMBER LOCATION	...	6B - 3
	EPA STICKER LOCATION	...	6B - 4
	THREADS	...	6B - 5
B	TECHNICAL DATA	...	6B - 7
	MANUFACTURING DATA AND DIMENSIONS	...	6B - 9
C	OPERATING AND MAINTENANCE	...	6B - 18
D	FAULT FINDING CHART	...	6B - 24
E	CYLINDER HEAD	...	6B - 36
F	PISTONS AND CONNECTING RODS	...	6B - 41
G	CYLINDER BLOCK AND LINERS	...	6B - 45
H	CRANKSHAFT AND MAIN BEARINGS	...	6B - 48
J	TIMING CASE AND DRIVE	...	6B - 54
K	TIMING	...	6B - 61
	FUEL INJECTION PUMP CALIBRATION CHART	...	6B - 63
L	LUBRICATING SYSTEM	...	6B - 67
M	COOLING SYSTEM	...	6B - 73
N	FUEL SYSTEM AND AIR CLEANERS	...	6B - 76
P	FLY WHEEL AND FLY WHEEL HOUSING	...	6B - 81
Q	APPROVED LUBRICATING OILS	...	6B - 83

Appendix - I ... 6B - 84

ENGINE NUMBER LOCATION

The engine number is stamped on the camshaft tunnel of the cylinder block (Right side of the engine)


SJ3·27E
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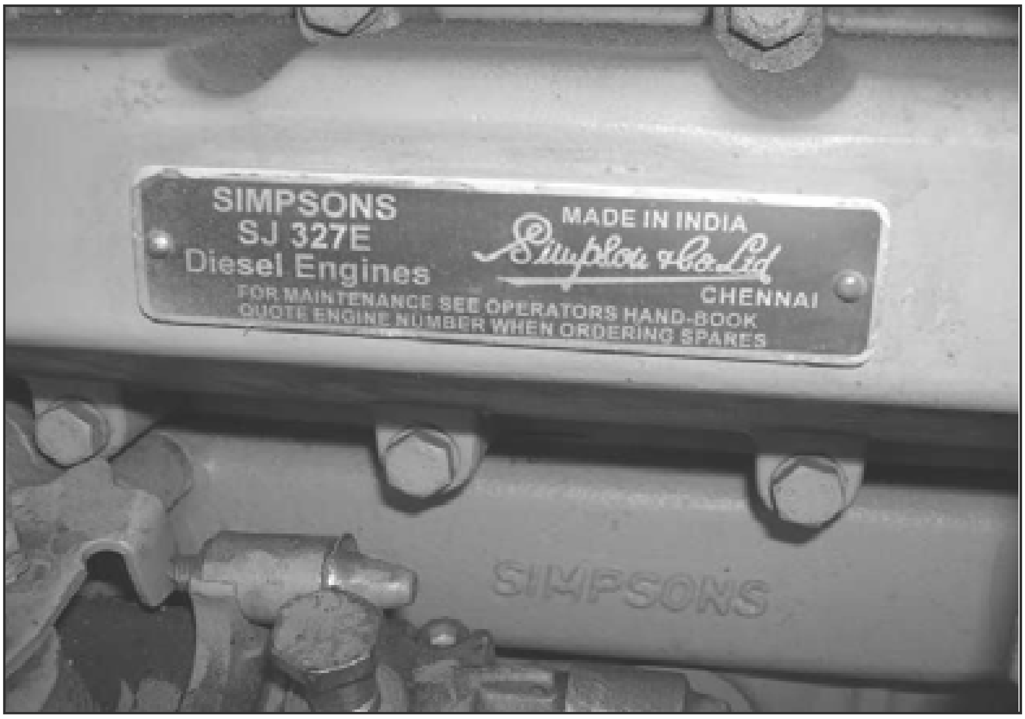
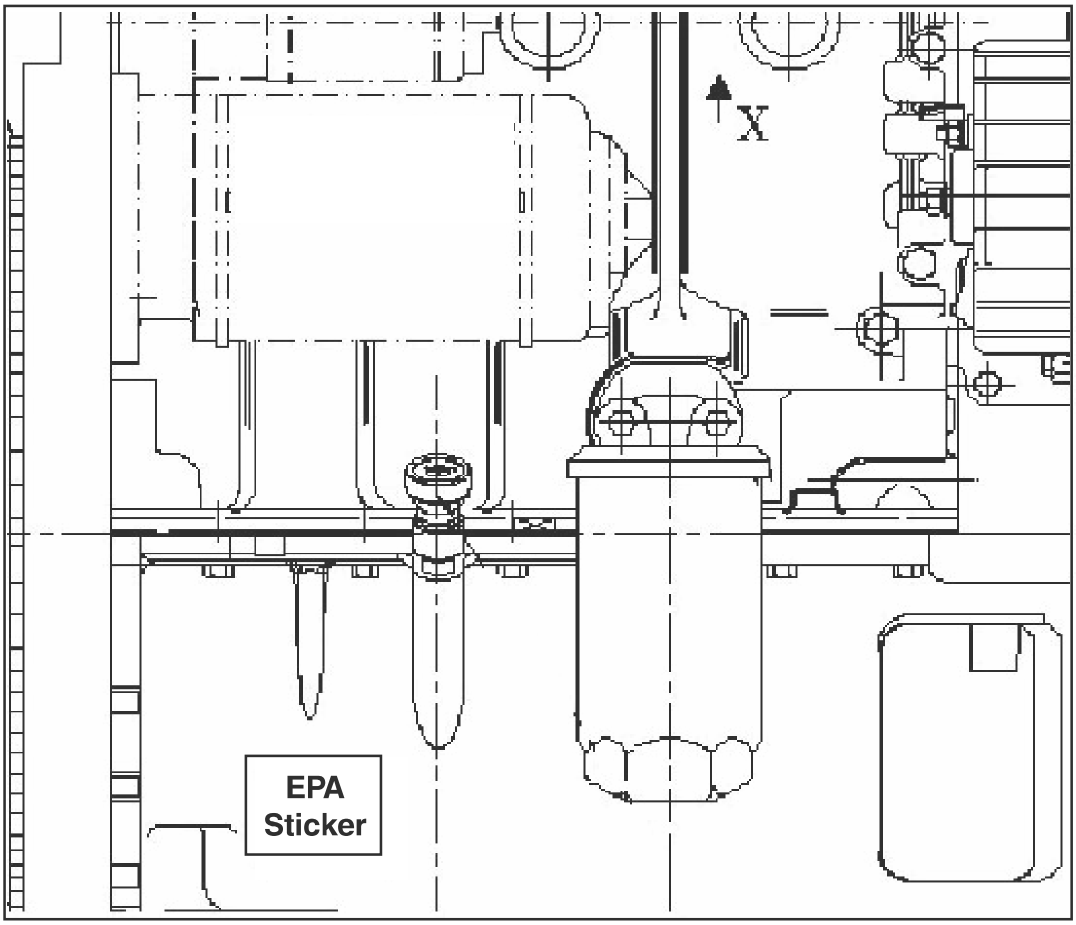

SIMPSONS
SJ 327E
Diesel Engines
MADE IN INDIA
Simpson & Co. Ltd
CHENNAI
FOR MAINTENANCE SEE OPERATORS HAND-BOOK
QUOTE ENGINE NUMBER WHEN ORDERING SPARES
SIMPSONS

Engine Name Plate Location

When requesting information regarding the engine. the number should be quoted.

ENVIROMENTAL PROTECTION AGENCY (EPA) LOCATION

The EPA Sticker is located on both sides of the engine oil sump



SIMPSONS 'SJ' SERIES DIESEL ENGINES

ALL THREADS USED ON SJ 327 E ENGINE ARE

METRIC SERIES

Except for the components indicated below :

1.	Bolt and Nut. Connecting Rod	7/16" – 20 UNF
2.	Setscrew. Balance Weight	7/16" – 20 UNF
3.	Thermostart fixing hole in the induction manifold	7/8" – 14 UNF
4.	De-aerator plug on water outlet body	1/4" – 18 NPSI
5.	Coolant temperature sender on coolant outlet body (RHS)	3/8" – 18 NPSI
6.	Lub oil pressure gauge tapping on cylinder block (LHS)	1/8" – 27 NPSI

Section B

TECHNICAL DATA

MANUFACTURING DATA AND DIMENSIONS

TECHNICAL DATA

SJ 327 E

Engine Type : 3 Cylinder. 4 Stroke. Inline Type. Coolant Cooled

Aspiration : Naturally Aspirated

Combustion : Direct Injection

Bore (Nominal dia.) : 3.74 inch (95.0 mm)

Stroke : 5.00 inch (127 mm)

Cubic Capacity : 0.713 gal (2.7 Lts.)

Compression ratio : 18.3 : 1

Rotation : Anti-clock wise from the flywheel end

Firing order : 1, 2 , 3

Valve Tip Clearance : 0.012 inch (0.30 mm) inlet and exhaust

Atomiser setting pressure : 250 + 8 bar (6 Spray Nozzle)

Inlet valve opens : 26.8° B.T.D.C.*

Exhaust valve closes : 25.3° A.T.D.C.**

Total inlet open period : 250.6°

Total exhaust open period : 266.6°

Fuel Injection Pump : MICO VE type fuel injection pump. mechanical governor

Injection timing : 0.0314 inch (0.8 mm) plunger lift when No.1 piston at TDC

Fuel feed pump : Plunger type pump located on cam tunnel. driven by engine camshaft

Application : Tractor

RATING :

Maximum Gross Rating PS (Kw) * : 49.6 (36.5) @ 2250 rpm

Maximum Gross Torque NM (Kgm) : 180 (18.35) @ 1200 – 1400 rpm

Rating Standard : ISO 14396

*** 1 Kw = 1.341 hp = 1.359 PS (or) CV**

DE-RATING FOR ALTITUDE :

Where engines are called upon to operate in very high atmospheres occasioned by altitude. such engines should be derated.

APPROXIMATE ENGINE WEIGHTS :

Basic weight (with alternator but without starter motor. flywheel & flywheel housing) :449.7 lb (204 Kg).

Typical installed weight (with starter motor. flywheel & flywheel housing) :639.3 lb (290 Kg).

ENGINE DIMENSION :

Height : 30.31 inch (770 mm). Length : 28.75 inch (730 mm). Width : 19.68 inch (500 mm).

* B.T.D.C. – Before Top Dead Center ** A.T.D.C. – After Top Dead Center

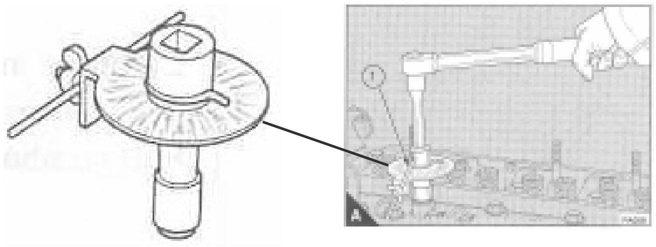
RECOMMENDED TIGHTENING TORQUES

	Nm	lbf.ft	Thread Size
Cylinder head setscrew **(Camshaft tunnel side)**	65	48	(M10 x 1.0)
Cylinder head setscrew	✡	✡	(M12 x 1.5)
Connecting rod nuts (Phosphated)	80	59	(7/16" - 20 UNF)
Main bearing setscrews	155	114	(M14 x 2)
Balance weight setscrews	75	55	(7/16" - 20 UNF)
Idler gear hub nut (lower and upper)	28	21	(M10 x 1.25)
Camshaft gear retaining setscrews	75	55	(M12 x 1.75)
F.I. pump adaptor to F.I. pump camshaft nut	45	33	(M12)
F.I. pump gear to adaptor setscrew	21	15	(M8 x 1.25)
Flywheel setscrews	110	81	(M12 x 1.25)
Crankshaft pulley retaining setscrews	150	111	(M22 x 2.5)
Thermostart	13.6	10	(7/8" - 14 UNF)
High pressure fuel pipe nuts	20	15	–
Atomiser *(Tighten using tubular spanner – Ref. Section E)*	60	44	(M24 x 1.5)

✡ Tighten the cylinder head setscrew in stages according to torque and in the order as shown below

Cylinder Head Tightening Procedure :

1. (a) Place non-asbestos type head gasket on locating dowels with "top mark" on gasket towards cylinder head. This "Non-retorque type" gasket should be fitted dry.
   (b) Ensure the cylinder head is located properly on dowel
   (c) Gradually and evenly tighten the setscrews to 33 lbf.ft.(45 Nm) in first turn using torque wrench
2. In second and third turn use angle torque as shown below :
   (a) Procedure for angle torque using special tool as shown in figure :



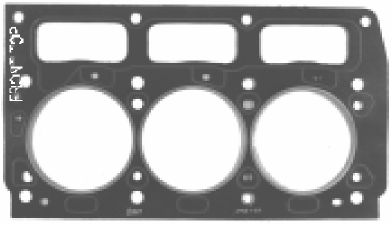
Special Tool used for angular torque

Fit the tool between the socket and the handle. Position the stop (Fig. A1) against a suitable protrusion on the cylinder head to prevent movement of the degree dial in a clockwise direction. Rotate the pointer to align with the relevent angle on the degree dial. Tighten the setscrew until the pointer on the tool is aligned with the zero position on the degree dial.

   (b) Procedure for angle forque if no special tool is available :

Make a suitable mark on the cylinder head in line with a corner of each setscrew as shown in the following figure. Make another mark. at the correct angle (counter-clockwise). on the edge of the flange of each fastener. Tighten each setscrew in the correct sequence until the marks on the flange are next to. and in line with. the marks on the cylinder head.

Head Gasket

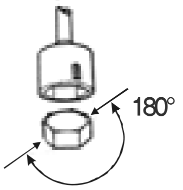


1st Turn 33 lbf.ft (45 Nm)

2nd Turn 180° in one movement

3rd Turn 180° in one movement

Tightening Procedure without special tool



MANUFACTURING DATA AND DIMENSIONS

The following data of clearances and tolerances are given as a guide for personnel engaged in major overhauls and the figures are those used in the factory for production purposes.

Cylinder Block

Height of cylinder block (Top to bottom faces)	13.743 / 13.740 inch (349. 085 / 349. 009 mm)
Parent bore dia. for Cylinder Liner	3.8583 / 3.8580 inch (98.022 / 98.000 mm)
Depth of Recess for Liner Flange (C.I. Liners)	0.157 / 0.155 inch (3.99/3.94 mm)
Dia Recess of Liner Flange (C.I. Liners)	4.0476 / 4.0437 inch (102.81/102.71 mm)
Main bearing parent bore	2.9175 / 2.9164 inch (74.105 / 74.079 mm)
No. 1 Bore for Camshaft	1.875 / 1.874 inch (47.625 / 47.600 mm)
No. 2 Bore for Camshaft	1.865 / 1.864 inch (47.375 / 47.350 mm)
No. 3 Bore for Camshaft	1.855 / 1.854 inch (47.125 / 47.100 mm)
No. 4 Bore for Camshaft	1.845 / 1.844 inch (46.865 / 46.840 mm)

Cylinder Liners – Cast Iron

Type - production liner	Dry semi finished – Interference fit.
- Service liner	Dry pre finished transition fit
Outside diameter of liner	3.861 / 3.860 inch (98.075 / 98.047 mm)
Interference fit of liner in Cylinder Block	0.003 / 0.001 inch (0.075 / 0.025 mm)
Inside dia. of finished liner in Cylinder Block	3.741 / 3.740 inch (95.022 / 95.000 mm)
Outside dia. of liner flange	4.040 / 4.037 inch (102.64 / 102.54 mm)
Flange thickness	0.158 / 0.157 inch (4.02 / 4.00 mm)
Liner protrusion above cylinder block machined surface	0.003 / 0.0011 inch (0.080 / 0.030 mm) (Above top face of block)

***NOTE :** Reboring to oversize is not recommended*

Pistons :

Type	Alfin Piston with re-entrant bowl and valve pockets on crown. Offset of combustion bowl in piston crown should be to the FI Pump side while assembling piston in engine. (Offset of valve pockets towards camshaft side)
Piston Height above cylinder block top face	0.0059 / 0.0035 inch (0.150 / 0.090 mm) (Above block surface)
Bore Dia. for Gudgeon Pin	1.2503 / 1.2501 inch (31.758 / 31.753) mm
Top ring Groove Width	0.118 inch (3.0 mm) (Nominal width) – Half Keystone ring
2nd ring Groove Width	0.080 / 0.079 inch (2.05 / 2.03 mm)
3rd ring Groove Width	0.159 / 0.158 inch (4.05/4.03 mm)

Piston Rings

Top Compression	Chromium inlaid. Half Keystone (Symetric barrel on periphery)
2nd Compression	Cast Iron. Taper land
3rd Oil Control	Conformable oil control ring

NOTE : *Conformable oil control ring fitment procedure*

a. Fit the helical coil spring on to the 3rd groove in the piston

b. Insert the latch into the coil spring aligning both the ends.

c. Fit the outer C.I. ring over the coil spring. Ensure coil spring gets seated properly inside the ring groove.

d. Also ensure the coil spring latch is on the opposite side of the ring open end gap.

Piston Ring Width

Top ring width	0.118 inch (3.0 mm) (Nominal)
2nd ring width	0.078 / 0.077 inch (1.99 / 1.97 mm)
3rd ring width	0.157 / 0.156 inch (3.990 / 3.970 mm)

Ring clearance in Piston Groove :

Top ring clearance in Groove	Nil (since keystone)
2nd and 3rd ring clearance in Groove	0.003 / 0.0015 inch (0.080 / 0.040 mm)

Ring Gaps

The ring gaps quoted below are for specified bore diameter. When checking ring gaps in a worn bore. 0.0031 inch (0.08 mm) should be added to these ring gaps for every 0.011 inch (0.03 mm) increase in bore diameter

Ring Gap – Top	0.0216 / 0.0011 inch (0.55 / 0.30 mm)
Ring Gap – 2nd	0.0393 / 0.0314 inch (1.00 / 0.80 mm)
Ring Gap – 3rd	0.0216 / 0.0011 inch (0.55 / 0.30 mm)

NOTE : *The ring gaps given above are for when checking in the unworn portion of the cylinder bore.*

Gudgeon Pin

Type	Fully Floating
Outside dia. of gudgeon pin	1.2497 / 1.2500 inch (31.744/31.750 mm)
Fit in piston boss	Transition
Clearance fit in Small end Bush	0.0005 / 0.0017 inch (0.0127 / 0.0441 mm)

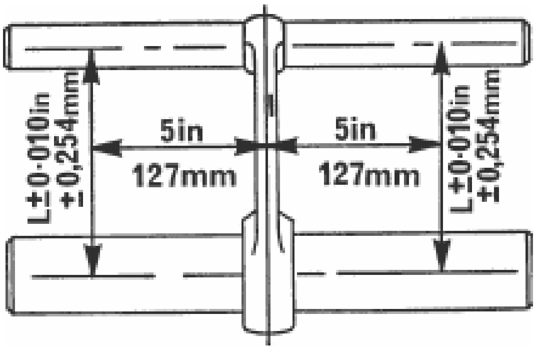
Small End Bush

Type	Steel Backed. Lead Bronze Lined
Outside Dia	1.3785 / 1.3800 inch (35.0139 / 35.052 mm)
Length	1.057 / 1.0381 inch (26.87 / 26.37 mm)
Inside Dia after reaming	1.2505 / 1.2515 inch (31.7627/31.7881 mm)

Connecting Rod

Type	"H" Section
Big end Parent Bore Dia	2.3948 / 2.3956 inch (60.83 / 60.85 mm)
Small end Parent Bore Dia	1.3748 / 1.3763 inch (34.92 / 34.96 mm)
Big end Width	1.5503 / 1.5523 inch (39.38 / 39.43 mm)
Big end side clearance on Crankpin	0.009 / 0.147 inch (0.236 / 0.375 mm)
Length between bore centers	8.8129 / 8.8118 inch (223.85 / 223.82 mm)

NOTE : *The numbered side of connecting rod and cap should be on the fuel injection pump side.*



Large and small end bores must be square and parallel to each other within the limits of ± 0.0098 inch (0.25 mm). measured 5.0 inch (127 mm) each side of the axis of the rod on test mandrel as shown in figure. With the small end bush fitted. the limit of ± 0.0098 inch (0.25 mm) is reduced to ± 0.0023 inch (0.06 mm). **Note** : *Connecting rod nuts should be replaced whenever the big ends are disturbe*d.

Fig. B1 Connecting Rod Alignment

Connecting Rod Bearings

Type	...	Pre-finished. Steel Backed Aluminium Tin (**or**) Copper lead
Inside Dia.	...	2.250 / 2.252 inch (57.19 / 57.21 mm)
Bearing Running Clearance	...	0.0023 / 0.0039 inch (0.06 / 0.10 mm)
Recommended sizes in service	...	0.0098 inch (0.25 mm) ;0.020 inch (0.51 mm) ;0.0299 inch (0.76 mm)

Crankshaft – (Ref. figure H2)

A –	Main Journal Dia. (Std.)	...	2.748 / 2.479 inch (69.81 / 69.83 mm)
B –	Crank pin Dia. (Std.)	...	2.248 / 2.249 inch (57.11 / 57.13 mm)
C –	Main Journal length Nos. 2 and 3	...	2.2145 / 1.2228 inch (30.85 / 31.06 mm)
D –	Crankpin length	...	1.5168 / 1.57 inch (39.67 / 39.88 mm)
E –	Main Journal Length-Rear	...	1.8425 / 1.8456 inch (46.80 / 46.88 mm)
R1 –	Main Journal fillet radii Nos. 1. 2 and 3	...	0.1248 / 0.14 inch (3.170 / 3.556 mm)
R2 –	Crankpin fillet radii	...	0.172 / 0.1559 inch (4.37 / 3.96 mm)
R3 –	Main Journal fillet radious No. 4 (Last)	...	0.1562 / 0.1661 inch (3.97 / 4.22 mm)
Surface finish (all Pins and Journals)		...	0.4 microns (Maximum)
Crankshaft end Float		...	0.00196 / 0.0149 inch (0.05 / 0.38 mm)
Crankshaft rear end Seal		...	Cassette type
Regrind Undersizes. Main and Pins		...	0.0098 inch (0.25 mm) ;0.020 inch (0.51 mm) ;0.0299 inch (0.76 mm)

NOTE : *When regrinding. the crank pin length should not exceed 1.5748 inch (40.00 mm) and the rear main journal (Crankshaft with lip type rear oil seal) length should not exceed 1.8610 inch (47.27 mm) and Nos. 2 and 3 main Journals width should not exceed 1.2275 inch (31.1785 mm) maximum.* ***The maximum permissible undersize is 0.0299 inch (0.76 mm)***

Crankshaft Thrust Washers

Type	...	Steel Backed. Aluminium Tin (or)Copper Lead
Position in engine	...	Cylinder Block Rear Main Bearing Housing
Thickness-Standard Size	...	0.1208 / 0.1228 inch (3.07 / 3.12 mm)
Thickness-Oversize	...	0.1283 / 0.1303 inch (3.26 / 3.31 mm)

NOTE : *While locating the Thrust Washers. ensure that the plain surface/Steel back is towards the block and the rear main bearing cap.*

Main Bearings

Type	...	Pre-finished. Steel Backed. Aluminium Tin/Copper Lead
Inside Dia. (fitted)	...	2.7519 / 2.7535 inch (69.90 / 69.94 mm)
Running clearance	...	0.0027 / 0.0051 inch (0.07 / 0.13 mm)
Recommended size in service	...	0.0098 inch (0.25 mm) ;0.020 inch (0.51 mm) ;0.0299 inch (0.76 mm)

Camshaft

Type	...	Polydine *(Hollow shaft. Journals are pressure feed lubrication. located with thrust washer)*
No. 1 Journal Dia.	...	1.8700 / 1.8694 inch (47.5 / 47.484 mm)
Running Clearance	...	0.0039 / 0.0055 inch (0.10 / 0.141 mm)
No. 2 Journal Dia.	...	1.8602 / 1.8596 inch (47.25 / 47.234 mm)
Running Clearance	...	0.0039 / 0.0055 inch (0.10 / 0.141 mm)
No. 3 Journal Dia	...	1.8503 / 1.8497 inch (47.00 / 46.984 mm)
Running Clearance	...	0.0039 / 0.0055 inch (0.10 / 0.141 mm)
No. 4 Journal Dia	...	1.8401 / 1.8395 inch (46.74 / 46.724 mm)
Running Clearance	...	0.0039 / 0.0055 inch (0.10 / 0.141 mm)
Oil way for rocker shaft lubrication	...	From head to 1st rocker bracket top face
Cam Lift *Inlet*	...	0.2512 inch (6.3814 mm)
Exhaust	...	0.292 inch (7.4169 mm)
Gear–Spigot dia	...	1.3779 / 1.3769 inch (35.000 / 34.975 mm)
Camshaft end float	...	0.0157 / 0.039 inch (0.40 / 0.10 mm)

Cylinder Head

Cylinder head total height	...	4.645 inch (118 mm)
Skimming allowance on head face	...	A maximum of 0.0118 inch (0.30 mm) may be removed from the Head Face provided the atomiser nozzle protrusion does not exceed 0.147 inch (3.75 mm) after skimming
Leak Test	...	4 Bar for 1 minute
Valve seat angle	...	Inlet 30° / Exhaust 45°
Tappet bore in cylinder head	...	0.6306 / 0.6299 inch (16.018 / 16.000 mm)
Valve guide bore in cylinder head	...	0.5125 / 0.5118 inch (13.018 / 13.000 mm)
Permissable cylinder head bow transverse and longitudinal	...	0.00314 inch (0.080 mm)

Valve Guides (Sintered) – Inlet and Exhaust

Inside Dia.	...	0.3110 / 0.3116 inch (7.900 / 7.915 mm)
Outside Dia	...	0.5127 / 0.5131 inch (13.023 / 13.034 mm)
Overall Length	...	2.3228 / 2.3149 inch (59.00 / 58.8 mm)
Guide Protrusion above Cyl. head Top Face	...	0.3917 / 0.3956 inch (9.95 / 10.05 mm)
Interference fit of guide in head	...	0.0013 / 0.00019 inch (0.034 / 0.005 mm)

NOTE : *Valve stem seal (with Sintered metal insert) is fitted in both inlet and exhaust valves.*

Inlet and Exhaust Valves

Valve Stem Dia *(Inlet)*	...	0.3101 / 0.3095 inch (7.877 / 7.863 mm)
Valve Stem Dia. *(Exhaust)*	...	0.3096 / 0.3090 inch (7.864 / 7.850 mm)
Clearance fit of valve in guide *(Inlet)*	...	0.00091 / 0.0025 inch (0.023 / 0.052 mm)
Clearance fit of valve in guide *(Exhaust)*	...	0.0014 / 0.0025 inch (0.036 / 0.065 mm)
Valve face Angle *(Inlet)*	...	29° 40’
Valve face Angle *(Exhaust)*	...	44° 40’
Valve depth below cylinder head face	...	0.0079 inch (0.203 mm) above or below *(Inlet and Exhaust)* cylinder head machined surface

Valve Seat Insert (Sintered)

Outer Dia.	Inlet	1.6602 / 1.6596 inch (42.170 / 42.154 mm)
	Exhaust	1.5254 / 1.5218 inch (38.670 / 38.654 mm)
Thickness	Inlet	0.242 / 0.2381 inch (6.15 / 6.05 mm)
	Exhaust	0.257 / 0.2530 inch (6.55 / 6.45 mm)

Valve Spring

Free length	1.771 inch (45.0 mm)
Fitted length	1.496 inch (38.0 mm)
Load at fitted length	111 lbf.ft (150 Nm)

Tappet

Outside Dia. of Shank	0.6292 / 0.6288 inch (15.984 / 15.973 mm)
Clearance fit in Cylinder head	0.0062 / 0.0017 inch (0.0160 / 0.0450 mm)

Rocker Shaft

Outside Diameter	0.748 / 0.747 inch (19.000 / 18.979 mm)

Rocker Lever

Bush Bore Diameter	0.7484 / 0.7504 inch (19.010 / 19.061 mm)
Running clearance of Bush on Shaft	0.00039 / 0.0032 inch (0.010 / 0.082 mm)

Timing Gears

Crankshaft gear – Steel	26 Teeth
Idler gear (Lower) – Steel	48 Teeth
Idler gear (Upper) – Steel	43 Teeth
Camshaft gear – C I	52 Teeth
Fuel Pump gear – Steel	52 Teeth

Camshaft Gear

Gear Bore Diameter	1.3789 / 1.3779 inch (35.025 / 35.00 mm)
Clearance fit of Gear on Spigot	0.000 / 0.0019 inch (0.00 / 0.05 mm)

Idler Gear and Hub (Upper / Lower) – *Gear Without Bush*

Bore Dia of gear	2.0007 / 1.9998 inch (50.818 / 50.795 mm)
Diameter of hub	1.9968 / 1.9956 inch (50.72 / 50.69 mm)
Clearance of gear on hub	0.0050 / 0.0029 inch (0.128 / 0.075 mm)
Gear Width	1.1935 / 1.1905 inch (30.315 / 30.239 mm)
Bearing length of hub	1.6019 / 1.5940 inch (40.69 / 40.49 mm)
Gear end-float	0.0079 / 0.0030 inch (0.203 / 0.077 mm)

Lower Idler Gear. Bush and Hub - *(Gear With Bush)* … *Optional for Front P.T.O. application only*

Idler Gear Hub Diameter	1.9960 / 1.9968 inch (50.70 / 50.72 mm)
Gear Bush Bore Diameter	1.9996 / 2.0007 inch (50.79 / 50.82 mm)
Clearance between Hub and Bush	0.0027 / 0.0047 inch (0.07 / 0.12 mm)
Hub Width	1.1905 / 1.1933 inch (30.24 / 30.31 mm)
Width of Gear with Bushes	1.1866 / 1.1874 inch (30.14 / 30.16 mm)
Idler Gear end Float	0.0079 / 0.0030 inch (0.203 / 0.077 mm)

NOTE :*The bore and faces of bushes should be finished to the specified dimensions by machining after pressing the bushes in the gear bore.*

Crankshaft Gear

Diameter of Bore	1.4996 / 1.5011 inch (38.090 / 38.13 mm)
Spigot Dia of crankshaft	1.5005 / 1.5000 inch (38.113 / 38.10 mm)
Transition fit of Gear on Crankshaft	0.011 / 0.0015 inch (0.03 / 0.04 mm)

Fuel Pump Gear *(Without timer)*

Diameter of Bore	1.8911 / 1.8916 inch (48.035 / 48.056 mm)
Pump adaptor Dia.	1.8897 / 1.8887 inch (48.000 / 47.975 mm)
Clearance fit of gear on spigot	0.0039 / 0.0022 inch (0.100 / 0.056 mm)

Timing Gear Backlash

All Gears	0.0031 inch (0.08 mm) (min.)

Lubricating Oil Pump

Oil Pump type	Rotor
Number of teeth on drive gear	19
Number of teeth on idler gear	15
Backlash between idler and drive gear	0.0031 / 0.0149 inch (0.080 / 0.380 mm)
Backlash between idler and C/S gear	0.01 / 0.0125 inch (0.254 / 0.320 mm)

Lubricating Oil Pump Drive Gear

Internal Dia. of Gear Bore	0.4960 / 0.4972 inch (12.60 / 12.63 mm)
Pump drive shaft Dia.	0.4988 / 0.4996 inch (12.67 / 12.69 mm)
Interference fit of Gear on Shaft	0.0019 / 0.0031 inch (0.05 / 0.08 mm)

Lubricating Oil Pump Idler Gear

Inside Dia. of Gear Bore	0.7500 / 0.7511 inch (19.05 / 19.08 mm)
Outside Dia. of Bush	0.7519 / 0.7535 inch (19.10 / 19.14 mm)
Interference fit of Bush in Gear	0.0011 / 0.0035 inch (0.03 / 0.09 mm)
Inside Dia. of Bush Fitted	0.6562 / 0.6570 inch (16.67 / 16.69 mm)
Dia. of Gear Shaft	0.6547 / 0.6551 inch (16.63 / 16.64 mm)
Running clearance of Gear on Shaft	0.0007 / 0.0025 inch (0.02 / 0.064 mm)
Gear end Float	0.0007 / 0.0228 inch (0.20 / 0.58 mm)

Lubricating Oil Pump Clearances

Inner Rotor to Outer Rotor	0.00039 / 0.0023 inch (0.01 / 0.06 mm)
Inner Rotor end clearance	0.0015 / 0.0031 inch (0.04 / 0.08 mm)
Outer Rotor end clearance	0.00039 / 0.0023 inch (0.01 / 0.06 mm)
Outer Rotor to Pump Body	0.0110 / 0.01299 inch (0.28 / 0.33 mm)

Lubricating System Pressure

Lubricating Oil Pressure	29.869 / 59.738 psi (2.1 / 4.2 kg per cm^2) at maximum engine speed and normal working temperature

Lubricating Oil Relief Valve

Type	Spring loaded plunger type valve
Pressure Setting	50.0662 / 65 psi (3.52 / 4.57 kg per cm^2)

Lubricating Oil Filter

Type	Full Flow
Element	Replaceable Paper / Canister
By-pass Valve Setting	12.94 / 17.06 psi (0.91 / 1.20 kg per cm^2)

Sump Capacity

... 1.585 gal (6 lts). Sump capacity vary according to application

Cooling System

Type	Thermosyphon-Pump assisted
Coolant capacity–Engine only	1.320gal (5 lts). (approximate)

Thermostat

Type	Wax
Opening temperature	167 ± 35.6°F (75° ± 2°C)
Fully open	192.2 ± 35.6°F (89° ± 2°C)

Water Pump

Type	Centrifugal
Outside Dia. of Shaft for Pulley	0.6263 / 0.6267 inch (15.91 / 15.92 mm)
Inside Dia. of Pulley Bore	0.6240 / 0.6248 inch (15.85 / 15.87 mm)
Interference fit of Pulley on Shaft	0.0015 / 0.0027 inch (0.04 / 0.07 mm)
Inside Dia. of Impeller Bore	0.6251 / 0.6255 inch (15.88 / 15.89 mm)
Ouside dia of shaft for impeller	0.6263 / 0.6267 inch (15.91 / 15.92 mm)
Interference fit of Impeller on Shaft	0.00039 / 0.0015 inch (0.01 / 0.04 mm)
Impeller to Body Clearance	0.00984 / 0.0200 inch (0.25 / 0.51 mm)
Distance between impeller rear face to the water pump pulley front machined face on the large Dia.	5.5314 ± 0.1496 inch (140.5 ± 0.38 mm)

Fuel System

Fuel oil specification	Fuel oil should conform to IS : 1460 / 2000 grade-special or grade-A specification.
Fuel Filter Type	MICO dual filter 0.132 gal (0.5 litre) capacity. spin on type (primary and secondary)
Fuel Overflow Valve Type	MICO spring loaded valve
Overflow Valve Location	Fuel Injection Pump
Fuel Feed Pump	Plunger type pump located on cam tunnel. driven by engine camshaft

Fuel Injection Pump

Make	…	MICO. India
Type	…	VE type
Mounting	…	Flange mounted
Drive	…	Gear
Pump Rotation	…	Anti-clockwise
Governor	…	VE type mechanical governor
Fuel injection timing	…	*Refer Sec. B / Sec.K*

Alternator

Make	…	**Lucas-TVS. India**
Volts	…	12 V
Max. Output	…	36 Amps

Starter Motor

Make	…	**Lucas-TVS. India**
Type	…	3SM114. 12 V Solenoid operated
No. of teeth on pinion	…	10
Starter Cable Resistance	…	0.0017 ohms maximum
Rotation	…	Normaly clockwise

Note : *The above electrical data is general and can vary with individual application*

Cold starting Aid (Standard fitment)

Device	…	Thermostart
Voltage	…	12 volts
Location	…	Induction manifold

Section C

OPERATING AND MAINTENANCE

OPERATING AND MAINTENANCE

Preparation for Starting

Check the radiator coolant level.

Check the engine sump oil level.

See that there is fuel oil in the tank

Check that the starter battery is fully charged and that all electrical connections are properly made and all circuits in order.

Starting the Engine

If the engine is warm. turn starter switch in a clockwise direction to the "Heat and Start" position (Ref. Fig. C.1.)

As soon as the engine starts. release the switch to the "ON" position.

Be sure that the starter pinion and engine have stopped rotating before re-engaging the starter motor. Otherwise damage may result.

If weather is cold. turn starter switch to the "Heat" position (Ref. Fig. C.1) and hold it there for fifteen to twenty seconds. (For – 59°F or 15°C) operation. hold it for 40 – 45 seconds)

Then turn the starter switch to the "Heat and Start" position. thereby engaging the starter motor.

If the engine does not start after twenty seconds. return the switch to the "Heat" position for ten seconds and then re-engage the starter motor by switching to the "Heat and Start" position.

As soon as the engine starts. release the switch to the "ON" position.

Starting the Engine (Alternative Method)

With some engines. a different starter switch may be found and the cold start aid operated by means of a separate push button switch.

The cold starting procedure is however the same. i.e.

Switch on by turning the starter switch in a clockwise direction to the first position

Press the heater button for fifteen to twenty seconds (For – 59°F(15°C) operation. press it for 40 – 45 seconds) and then. with the heater button still pressed. turn the starter switch in a further clockwise direction to engage the starter motor. As soon as the engine starts. release both starter switch and heater button.

Cold Starting Aid

Referring to Fig. C.2 the cold start unit comprises a tubular valve body carried in a holder which screws into the inlet manifold. and surrounded by a heater coil. an extension of which forms an igniter coil. The valve body houses a needle. the stem of which holds a ball valve in position against its seating. The whole is surrounded by an open perforated shield. Fuel oil from the container enters through an adaptor.

When the unit is cold. the ball valve is held closed. On switching on the coil. the valve body is heated and

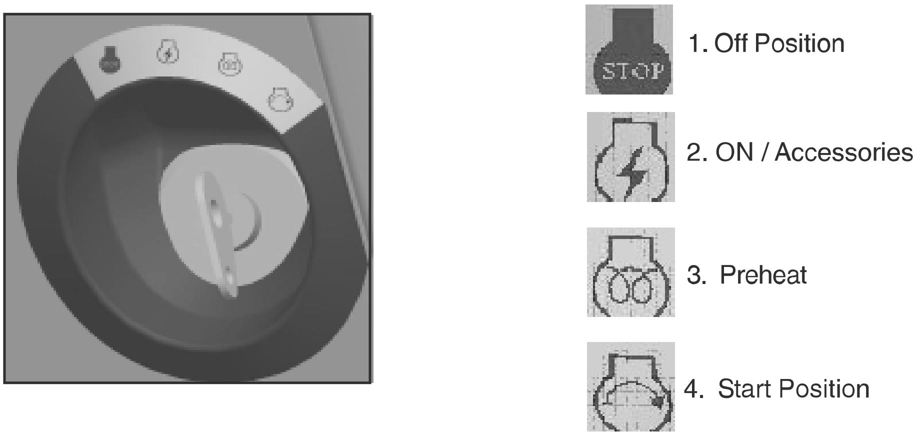


Fig. C. 1 Combination Switch

expands. opening the ball valve and permitting the entry of fuel. The fuel is vapourised by the heat of the valve body and when the engine is cranked and air is drawn into the manifold. the vapour is ignited by the coil extension and continues to burn. thus heating the inlet air. (Refer Fig. C3 for cold start layout).

To Stop the Engine

A spring loaded stop control is located near the engine controls and functions by cutting off the fuel at the fuel injection pump.

Turn start switch to the Off position.

Things to Note

Always be sure that the starter pinion has stopped revolving before re-engaging the starter. otherwise the ring or pinion may be damaged.

Ensure that the electrical connection to the cold starting aid is correctly made. (Ref. Fig. C. 3)

Always ensure that. if a reservoir is used to feed fuel to the starting aid. it is fully primed and is not leaking. On later engines. the starting aid fuel feed is taken directly from the fuel tank or fuel filter.

When the coil is switched off. the flow of air in the manifold cools the valve body rapidly and the valve closes.

The cold start aid is a sealed unit and cannot be dismantled. If the unit ceases to function. it must be renewed.

In the event of difficult starting. check that fuel is reaching the cold starting aid in the induction manifold by unscrewing the inlet fuel connection. If fuel is reaching it satisfactorily. then it may be that the cold starting aid itself is not working correctly. This can be checked by removing the air cleaner and watching the cold starting aid whilst the equipment is used. When the starting switch is turned to the "heat" position. the element should become red hot. and on engagement of the starter motor. it should ignite into flames.

SJ327 E engines are fitted with efficient cold starting equipment and no responsibility can be accepted for any damage caused by unauthorised starting aids.

Running-in Procedure

It is not necessary to gradually run-in a new engine and any prolonged light load running during the early life of the engine and in could prove harmful to the run in of piston rings and liners.

Full load can be applied on a new engine as soon as the engine is used. Provided that the engine coolant is first allowed to reach a temperature of at least 140° F (60° C).

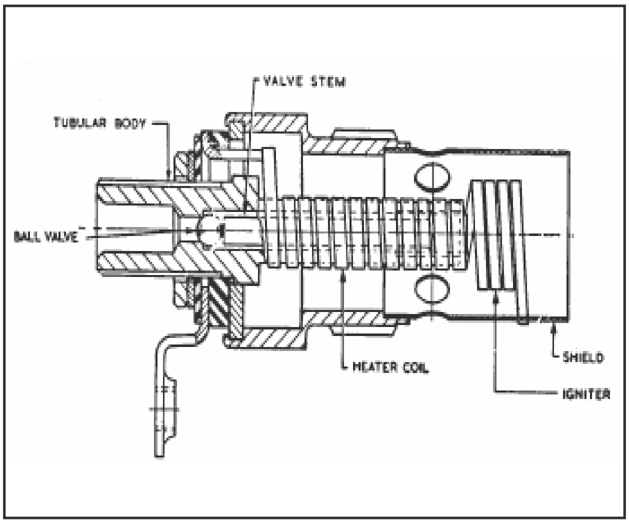


Fig. C 2 – Thermostart

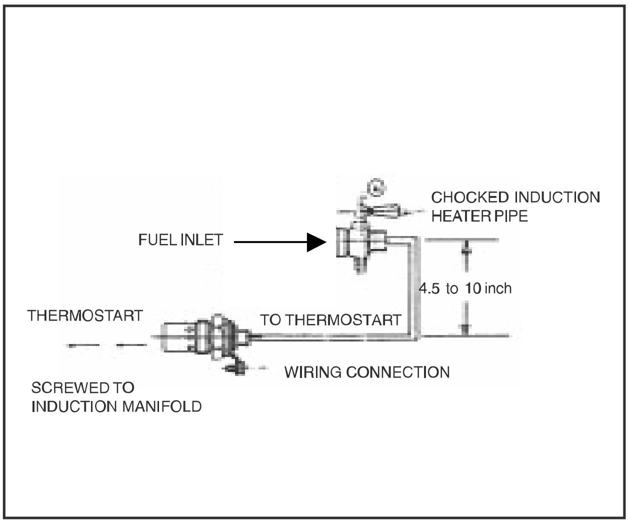


Fig. C 3 – Typical Layout of Cold Start Aid

PREVENTIVE MAINTENANCE

DAILY OR EVERY 8 HOURS WHICHEVER OCCURS FIRST:

Keep Engine Clean.

Check level of coolant.

Check level of oil in sump.

Check oil pressure (where gauge fitted).

EVERY 250 HOURS:

Drain and renew lubricating oil. Refer to list of Approved lubricating Oils in Sec. Q.

Renew lubricating oil filter (canister).

Check drive belt tension.

* Clean and replace paper element (Dry type air cleaner)

Clean fuel lift pump pre-filter (where fitted).

Check engine for leakage of oil and coolant.

EVERY 500 HOURS :

Check hoses and clamps.

Check atomisers.

Examine valve springs and check valve tip clearances.

Inspect valve rocker shaft assembly for lubrication.

Clean and treat battery terminals.

EVERY 1000 HOURS:

Drain fuel tank. remove and clean.

Flush radiator with clean coolant.

**** NOTE :***

(a) *The time for cleaning the air cleaner depends on operating conditions; therefore under extremely dusty conditions. the time limit recommended above for cleaning should be decreased.*

The correct maintenance of the air cleaner will greatly assist in reducing bore wear. thereby extending the life of the engine.

(b) *Dry Type Air Cleaner with Turbo Type Pre Cleaner*

- Main Paper Element can be cleaned twice only with pressurized air (applying from inside to outside) before replacement. Remove the Main Paper Element from the assembly for cleaning purpose.
- 1st Cleaning after 100 Hrs.
- 2nd cleaning after 200 Hrs.
- Discard after complete plugging.
- Inner secondary element has been provided to safeguard against dust entry in case of puncturing of Main Element. It is to be replaced with the fitment of third Main Paper Element.
- Remove the dust every 50 Hrs. from dust unloader by press opening the lip.

FUEL FILTERS MAINTENANCE

Do not clean filter canister.

Drain filter bowls after every 125 hrs. of operation by loosening sludge screws (wherever provided). until clean fuel flows out.

DUAL FILTERS

Replace first stage filter (primary) after every 500 hrs. (spin on type).

Replace second stage filter (secondary) after every 750 hrs. (spin on type).

Operators of SJ327 E engines are reminded that the above Preventive Maintenance are general in application: therefore the operator should compare the routine maintenance for their engine with the schedules specified by the manufacturer of the application to which the engine is fitted and where necessary adopt the shorter periods.

While we have given specific periods for preventive maintenance. you should have due regard for the local regulations concerning your machine and ensure that the engine is operating within those regulations.

Post-Delivery Checkover

After a customer has taken delivery of their diesel engine. it is advisable in their own interest that a general checkover of the engine be carried out after the first 25 hours in service.

It is also recommended that the following procedure be adopted where an engine has been stored for a considerable period before it is again put into service.

The checkover should comprise the following points:-

1. Drain lubricating oil sump and re-fill up to the full mark on the dipstick with new clean oil (Do not overfill).
2. Renew the lubricating oil filter (canister).
3. Check external nuts for tightness.
4. Check and adjust valve tip clearances to 0.012 inch (0.30 mm) to inlet and exhaust valve cold or hot.
5. Check fuel pipes from tank to fuel injection pump for leaks.
6. Check for lubricating oil leaks and rectify if necessary.
7. Check hose clamps for tightness.
8. Check cooling system for leaks and inspect radiator coolant level.
9. Check fan belt for tension.
10. Carry out test to check general performance of engine.
11. Check engine mounting bolts for tightness.

It is assumed that electrical equipment will have already been checked for such points as rate of charge. effectiveness of connections and circuits. etc.

Thereafter maintenance periods should be in accordance with the instructions given.

Preservation of stored Engines

Where an application which is powered by Simpsons engine is to be stored for several months it is advisable that some measure of protection be afforded to the engine to ensure that it suffers no ill effects during the intervening period before operations are recommenced.

It is recommended therefore, that the following procedure be adopted and applied immediately if the unit is removed from service:

1. Thoroughly clean all external parts of the engine.
2. Run the engine until it reaches operating temperature. Stop the engine and drain lubricating oil from sump.
3. Drain coolant from radiator and engine cylinder block.
4. After replacing filters fill the sump to correct level with clean new lubricating oil or with a suitable preservative fluid.
5. Remove atomisers and spray into cylinder bores 150 ml of lubricating oil divided between the cylinders.
6. Turn engine slowly over compression and replace atomisers.
7. Remove air cleaner and any intake pipe which may be fitted between the air cleaner and air intake. Carefully seal air intake orifice with waterproof adhesive tape or some other suitable medium.
8. Remove exhaust pipe and seal opening in manifold as in ‘7’.
9. Disconnect battery and store in fully charged condition. Before storing the battery. terminals should be treated to prevent corrosion.

The fuel system may either be drained and charged with a suitable preservative designed for the prevailing climatic conditions or alternatively. it may be left primed with normal fuel oil.

Where the latter course is taken it should be noted that deterioration of the fuel oil may occur during the months the fuel system is idle.

If this occurs. the fuel oil may become contaminated with a wax-like substance which will quickly clog the fuel filtering arrangement once the engine is returned to service.

Therefore. before commencing operations in respect of a unit primed with normal fuel oil which has been idle for several months it is recommended that the fuel tank be drained and the interior of the tank thoroughly cleaned. The fuel oil drained off should be discarded as unfit for further use.

Fuel oil contained in the remainder of the fuel system should also be dispelled and the fuel filter renewed. following which the system may then be recharged with fresh clean fuel oil.

Before starting. the engine should be cranked over by the starter motor with the stop control in the ’off’ position until oil pressure is recorded or the oil warning light is extinguished. Do not rapidly accelerate the engine after initial start. allow it to run at slow speed for approximately two minutes to ensure good oil circulation before accelerating to higher speeds.

NOTE: *Where a preservative is used in the lubricating oil sump. this should be drained off and replaced by normal lubricant prior to restarting the engine at the end of the storage period. In the case of a preservative being utilised to charge the fuel system. this need not necessarily be drained off before returning the engine to service. Therefore. where a preservative is used in this respect. the relevant manufacturers of the fluid should be contacted seeking their guidance as to whether their product should be drained away prior to restarting the engine.*

Frost Precautions

Precautions against damage by frost should be taken if the engine is to be left exposed to inclement weather either by adequately draining the coolant system or where this is not convenient an anti-freeze of reputable make and incorporating a suitable corrosion inhibitor may be used.

Should it be the policy to protect engines from frost damage by adding anti-freeze to the cooling system. it is advisable that the manufacturers of the relevant mixture be contacted to ascertain whether their products are suitable for use in Simpsons engines. and also to ensure that their products will have no harmful effect on the cooling system generally. It is our experience that the best results are obtained from anti-freeze which conforms to ***British Standard 3151*** or has been approved by testing in accordance with ***BS 5117. Clause 5.*** to give atleast as good a result as ***BS 3151:1959.***

The coolant solution containing 25 per cent ***anti-freeze manufactured to BS 3151*** in coolant in a properly maintained engine should maintain its anti-freeze and anti-corrosive properties throughout the winter season and in general. a safe life of 12 months may be reasonably expected.

When draining the coolant circulating system it is not enough merely to open the radiator drain tap. The one on the cylinder block must also be opened. This tap is on the rear side of the cylinder block. near the flywheel housing.

Where a pressurised radiator filler cap is fitted. this should be removed before draining the cooling system.

When draining the cooling system ensure that the engine is level.

When the engine cooling coolant is drained. in the majority of applications the water pump is also drained. but rotation of the pump may be prevented by :

(a) Locking of the impeller by ice due to the pump drain hole being blocked by sediment.

(b) The locking of the seal through the freezing of globules of moisture between the seal and the gland.

Operators are therefore advised to take these precautions when operating in temperatures below freezing point:

1. Before starting the engine. turn the fan and water pump by hand: this will indicate if freezing has taken place. If freezing has taken place. this should free any ice formation.
2. If it is impossible to turn the pump by hand. the radiator and engine should be filled with warm water.

After an anti-freeze solution has been used. the cooling system should be thoroughly flushed in accordance with the manufacturer's instructions before refilling with normal coolant.

If the foregoing action is taken. no harmful effects should be experienced. but manufacturer cannot be held responsible for any frost damage or corrosion which may be incurred.

Section D

FAULT FINDING CHART

SECTION D FAULT FINDING CHART

The following table lists problems and their possible causes with recommended action.

IMPORTANT : *When attending/performing a repair, the cause of the problem must also be investigated and corrected to avoid repeat failures.*

PROBLEM	POSSIBLE CAUSES	REMEDY
LOW CRANKING SPEED	Battery capacity low	Change or renew the battery
	Bad electrical connections	Check the connections or renew electricals
	Faulty starter motor	Overhaul starter motor
	Lubricating Oil of incorrect grade	Drain and refill with specified grade of oil
ENGINE DOES NOT START	Low cranking speed	See Problem – Low Cranking speed
	Fuel tank empty	Fill the tank with fuel
	Incorrect type or grade of fuel	Drain and refill with correct type/grade of fuel
	Faulty stop control operation	Check the stop control cable movement and setting
	Blocked fuel feed/supply pipe	Clean the pipe
	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Chocked/Plugged fuel filters	Renew filter elements
	Air in fuel system	Remove air lock/Bleed air
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Broken fuel injection pump drive	Fit new drive
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor Compression
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Pitted valve/s and seat/s	Replace valve with new standard or oversize, and/ or machine the valve guide bores
	Broken, worn or sticking piston ring/s	Fit new ring/s, check bore and pistons for damage

PROBLEM	POSSIBLE CAUSES	REMEDY
DIFFICULT STARTING	Low cranking speed	See Problem – Low Cranking Speed
	Faulty stop control operation	Check the stop control cable movement and setting
	Blocked fuel feed/supply pipe	Clean
	Blocked fuel tank vent	Clean
	Incorrect type or grade of fuel	Drain the fuel and refill with correct grade of fuel
	Exhaust pipe restriction	Check and clean/remove the restrictions
	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Restricted fuel filters	Renew filter elements
	Restriction in air cleaner or induction system	Check and clean/remove the restriction
	Air in fuel system	Remove air lock/Bleed air
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor Compression
	Sticking valves	Replace valve with new standard or oversize, and/ or machine the valve guide bores
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Pitted valves and seats	Replace valve with new standard or oversize, and/ or machine the valve guide bores
	Broken, worm or sticking piston ring/s	Fit new rings, check bore and pistons for damage

PROBLEM	POSSIBLE CAUSES	REMEDY
MISFIRING	Restricted fuel feed/supply pipe	Clean pipe
	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Restricted fuel filters	Remove filter elements
	Air in fuel system	Remove air lock/Bleed air
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor compression
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Overheating	See Problem – Overheating
	Incorrect tappet adjustment	Check and reset the adjustment
	Sticking valves	Replace valve with new standard or oversize, and/or machine the valve guide bores
	Incorrect high pressure pipes	Renew the pipes of correct specification
	Pitted valves and seats	Replace valve with new standard or oversize, and/or machine the valve guide bores.

PROBLEM	POSSIBLE CAUSES	REMEDY
EXCESSIVE CRANKCASE PRESSURE	Plugged breather pipe	Clean the pipe
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Worn valve stems and guides	Renew valves and guides
	Piston seized inspect the bore for damage	Replace with new pistons assembly and check/
POOR COMPRESSION	Overheating	See Problem – Overheating
	Incorrect valve timing	Reset the timing
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Incorrect tappet adjustment	Check and reset the adjustment
	Sticking valves	Replace valve with new standard or oversize and / or machine the valve guide bores
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Pitted valves and seats	Replace valve with new standard or oversize, and/ or machine the valve guide bores
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and piston for damage
	Worn valve stems and guides	Renew valves and guides
	Broken valve springs	Fit new springs

PROBLEM	POSSIBLE CAUSES	REMEDY
LACK OF POWER	Blocked fuel feed/supply pipe	Clean the pipe
	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Restricted fuel filters	Remove filter components
	Plugged fuel tank vent	Clean
	Restriction in air cleaner or induction system	Check and clean/remove the restriction
	Air in fuel system	Remove air lock/Bleed air
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Incorrect fuel pump timing	Check and reset
	Incorrect vale/valve timing	Check and reset
	Poor compression	See Problem – Poor Compression
	Incorrect type/grade of fuel	Drain the fuel and refill with correct grade of fuel
	Sticking throttle or restricted movement	Check, clean, lubricate and adjust settings
	Exhaust pipe restriction	Check and clean/remove the restrictions
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Overheating	See Problem – Overheating
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Pitted valves and seats	Replace valve with new standard or oversize, and/or machine the valve guide bores
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage

PROBLEM	POSSIBLE CAUSES	REMEDY
EXCESSIVE FUEL CONSUMPTION	Restriction in air cleaner or induction system	Check and clean/remove the restriction
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul Injectors
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor compression
	Incorrect type or grade of fuel	Drain the fuel and refill with correct grade of fuel
	Sticking throttle or restricted movement	Check, clean, lubricate and adjust settings
	Exhaust pipe restriction	Check and clean/remove the restrictions
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Incorrect tappet adjustment	Check and reset the adjustment
	Sticking valves	Replace valve with new standard or oversize and/or machine the valve guide bores
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Pitted valves and seats	Replace valve with new standard or oversize and/or machine the valve guide bores
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage

PROBLEM	POSSIBLE CAUSES	REMEDY
BLUE/WHITE SMOKE	Incorrect grade of lubricating oil	Drain and refill with specified grade of oil
	Overfilled air cleaner oil or use of incorrect grade (wet type air cleaner)	Check the oil level and remove as necessary or of oil refill with correct grade oil
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Poor compression	See Problem – Poor Compression
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Incorrect tappet adjustment	Check and reset the adjustment
	Worn cylinder bores	Re-sleeve block and fit new pistons
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Worn valve stems and guides	Renew valves and guides
	Piston seized damage	Replace piston assembly and check the bore for
LOW ENGINE OIL PRESSURE	Incorrect grade of lubricating oil	Drain and refill with specified grade of oil
	Worn or damaged big end bearings	Renew the bearings
	Insufficient oil in sump	Top up as necessary
	Oil gauge faulty	Fit new gauge
	Oil pump worn	Renew oil pump
	Oil pressure relief valve faulty	Fit new relief valve
	Faulty suction pipe	Renew the pipe
	Chocked/Plugged oil filter	Replace with new filter
	Plugged sump strainer	Clean the strainer

PROBLEM	POSSIBLE CAUSES	REMEDY
ENGINE KNOCKS	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Faulty injectors	Overhaul injectors
	Incorrect fuel pump timing	Check and reset
	Incorrect valve timing	Check and reset
	Incorrect type or grade of fuel	Drain and refill with correct grade of fuel
	Overheating	See Problem – Overheating
	Incorrect tappet adjustment	Check and rest the adjustment
	Sticking valves	Replace valve with new standard or oversize, and / or machine the valve guide bores
	Worn cylinder bores	Re-sleeve block and fit ne pistons
	Broken, worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Overfilled cleaner or use of Incorrect grade of oil (Wet type Air cleaner)	Check the level or drain out and refill with correct grade oil
	Worn or damaged big end bearings	Renew the bearings
	Piston seized damage	Replace piston assembly and check the bore for
	Broken valve spring	Replace new springs

PROBLEM	POSSIBLE CAUSES	REMEDY
VIBRATION	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Poor compression	See Problem – Poor Compression
	Sticking throttle or restricted movement	Check, clean, lubricate and adjust settings.
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Overheating	See Problem – Overheating
	Sticking valves	Replace valve with new standard or oversize, and/or machine the valve guide bores
	Incorrect high pressure pipes	Renew with pipes of correct specifications
	Broken worn or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Piston seized damage	Replace piston assembly and check the bore for
	Faulty engine mounting	Check and redo the installation of engine
	Incorrectly aligned flywheel housing or flywheel	Check and align flywheel housing and flywheel
HIGH OIL PRESSURE	Incorrect grade of lubricating oil	Drain and refill with specified grade of oil
	Inaccurate relief gauge	Check and renew gauge
	Pressure relief valve faulty	Fit new relief valve
STARTS & STOPS	Restriction Plugged fuel filter	Fit new filter
	Restriction in air cleaner or induction system	Remove the restriction
	Air in fuel system	Remove the air lock/Bleed air

PROBLEM	POSSIBLE CAUSES	REMEDY
ERRATIC RUNNING	Sticking throttle or restricted movement	Check, clean, lubricate and adjust settings
	Overheating	See Problem – Overheating
	Incorrect tappet adjustment	Check and reset the adjustment
	Sticking valves	Replace valve with new standard or oversize, and/or machine the valve guide bores
	Incorrect high pressure pipes	Renew the pipes of correct specifications
	Broken, worn-out or sticking piston ring/s	Fit new rings, check bore and pistons for damage
	Piston seized	Replace piston assembly and check the bore for damage
	Broken valve spring	Replace with new springs

ERRATIC RUNNING	Faulty stop control operation	Check the stop control cable movement and setting
	Resticted fuel feed/supply pump	Clean
	Faulty fuel feed/supply pump	Overhaul fuel feed/supply pump
	Plugged fuel filters	Chocked fuel filters
	Restriction in air cleaner or induction system	Check and clean/remove the restriction
	Air in fuel system	Remove air/Bleed air lock
	Faulty fuel injection pump	Overhaul injection pump
	Faulty injectors	Overhaul injectors
	Poor compression	Renew piston rings or re-sleeve as necessary
	Plugged fuel tank vent	Clean the vent

PROBLEM	POSSIBLE CAUSES	REMEDY
OVERHEATING	Coolant level too low	Top up as necessary
	Loose fan belt	Tighten the fan belt
	Faulty Temperature gauge	Check and replace
	Restriction in coolant jacket	Remove the restriction by reverse flushing entire cooling system
	Plugged radiator	Clean and check for free flow
	Restriction in air cleaner or induction system	Check and clean/remove the restriction
	Damaged fan	Fit new fan
	Faulty thermostat	Replace with new thermostat
	Faulty water pump	Overhaul or renew the water pump
	Exhaust pipe restriction	Remove the restriction
	Faulty injector	Overhaul Injector
	Incorrect fuel pump timing	Reset the timings
	Incorrect valve timing	Reset valve timings
	Cylinder head gasket leaking	Check the cylinder head bolts torque or renew the gasket
	Faulty fuel injection pump	Overhaul injection pump
	Piston seized damage	Replace piston assembly and check the bore for

Section E

CYLINDER HEAD

CYLINDER HEAD

The number of hours run has no bearing on when to overhaul the cylinder head because carbon. beyond a superficial coating does not form and accumulate in the combustion chambers and on the pistons as is the case with a gasoline engine.

Ease of starting and performance are the determining factors. Therefore the cylinder head should only be removed when it is absolutely necessary.

To Remove the Cylinder Head

1. Drain coolant from radiator and cylinder block.
2. Detach coolant connections from thermostat housing on front of cylinder head.
3. Remove air cleaner and hose connection.
4. Detach cold starting equipment connections (if fitted).
5. Disconnect the exhaust pipe from the engine exhaust manifold.
6. Disconnect closed breather hose from oil separator
7. Remove the injection pipes from the fuel pump to atomisers.

   Warning:- Cover the fuel pump delivery ports with suitable protective caps.
8. Remove atomiser leak-off pipes
9. Remove the atomisers (Use 24 mm tubular spanner as shown in Fig. E5 / E6)
10. Remove the cylinder head cover.
11. Remove the rocker shaft assembly (Fig. E1) by loosening rocker bracket setscrews.
12. Remove the push rods (provide tappet holding sticks in all tappet holes to hold the tappets in position while removal).
13. Remove the cylinder head setscrews.
12. Remove the cylinder head. Do not insert screwdriver or any other sharp instrument between the cylinder head and block. Place the cylinder head on a flat surface preferably wood to avoid damage.

To Remove the Valves

Depress the spring cap. and spring by means of a valve spring compressor and remove the two half conical collets.Remove the spring caps springs and washers thus freeing the valves for removal. The valves and valve seats should be reconditioned in the normal way using grinding compound or by means of specialised equipment.

The valve seat angle is 30° for inlet valve and 45° for exhaust valve.

Do not forget that the efficiency of a diesel engine depends largely on the maintenance of good compression. Contact between valve and seatings must therefore be the best possible.

Care should be taken to avoid unnecessary grinding away of the seat as the maximum clearance between the valve head and the cylinder head bottom face should not exceed ± 0.0079 inch (0.203 mm) for both the inlet and exhaust valve. This can easily be checked by means of a suitable gauge and feelers.

The SJ327 E engine have valve seat inserts fitted in the cylinder head for both inlet and exhaust valves (Valve seats are press fit in normal ambient condition).

The valve seats on ‘SJ’ Series engines are recessed into the cylinder head and a groov is cut where the proper valve seat ends in the mitred recess in the head. When valves have been reconditioned several times. it is possible that the valve may become masked by sinking too low in the cylinder head and in these circumstances the valve seat insert should be replaced.

During service if the valves were numbered and the cylinder head to be marked with corresponding numbers.

In factory manufactured engines the valves and seats are not numbered and where a valve is to be used again it should be suitably marked to ensure it is replaced in its original position.

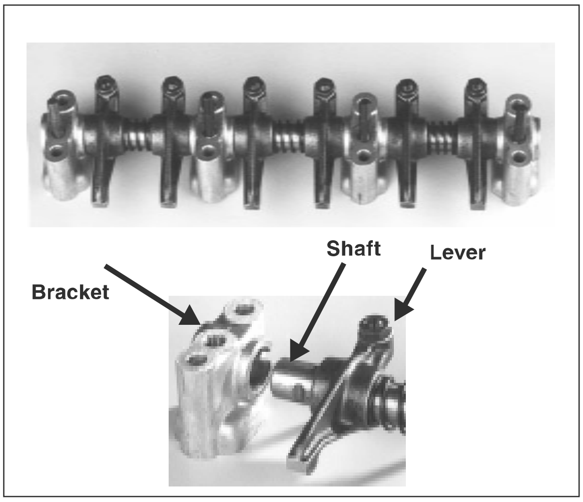


Fig. E 1 – Rocker Assembly

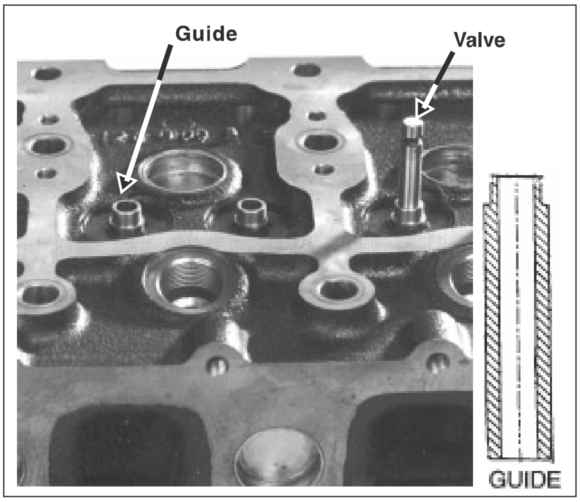


Fig. E 2 – Valve / Guide Protrusion

Rocker Levers and Bushes

Wash the rocker shaft assembly thoroughly in cleaning solvent.

Examine the rocker bushes for wear. The rockers should be an easy fit on the shaft without excessive side play.

If the rocker bushes are worn. it will be necessary to replace with a new bush and reamed to correct size.

When dismantling rocker shaft assembly (Fig. E1) make careful note of the order of assembly of the various parts. supports. springs and rockers so that re-assembly may be facilitated and that rockers are correctly placed and opposite of their respective push rods and valves as show in Fig. E 3.

Valve Guides

Examine the valve guides for wear. if necessary replace with new guides.

Clean the new guides. removing any burrs.

When pressing in a valve guide. care must be taken to ensure it is installed the correct way. Both the guides inlet and exhaust are interchangeable (Valves are not interchangeable). One end of this guide is stepped as shown in Fig. E2. This end should come on cylinder head top while inserting the guide. The stepped end of this guide should protrude 0.3917 / 0.3956 inch (9.95/10.05 mm) above cylinder head top face.

NOTE : *In production valve guide inner dia is finished by reaming along with valve seat in single operation.*

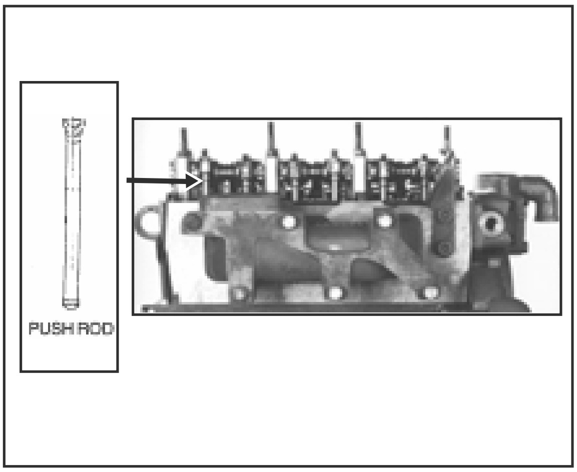


Fig. E 3 – Push Rod Location

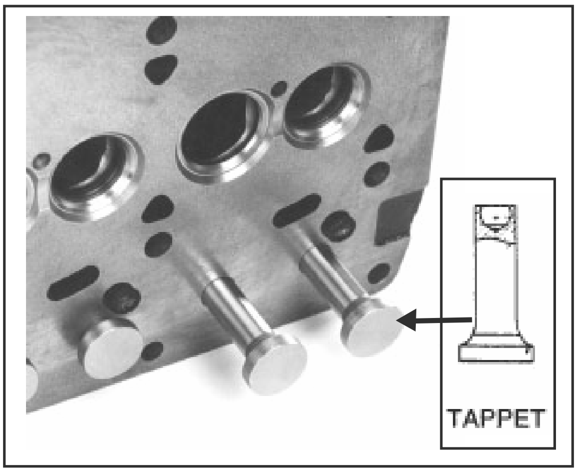


Fig. E 4 – Cylinder Head / Tappet

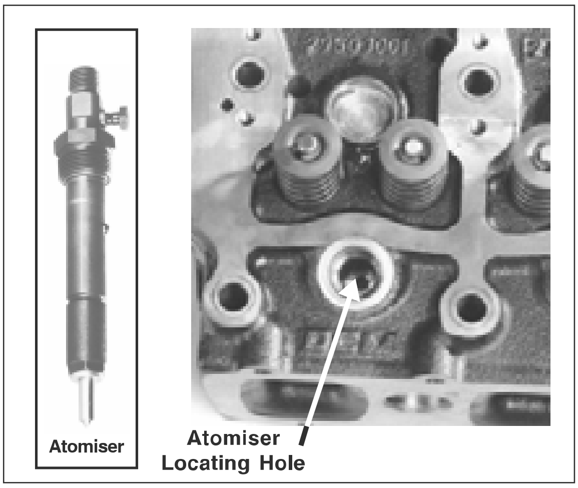


Fig. E 5 – Atomiser / Locating Hole

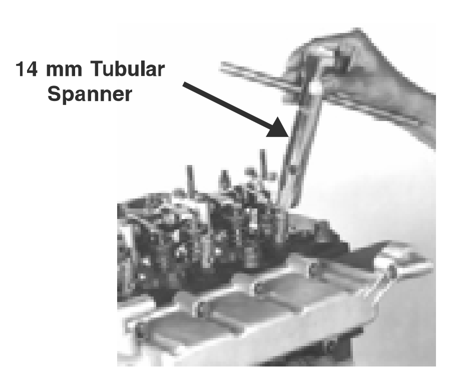


Fig. E 6 – Atomiser Tightening Tool

Tappets

The tappets slide in holes bored in the cylinder head as shown in Fig. E 4. The wear.under normal conditions. is negligible.

While fitting cylinderhead assembly with tappets use “tappet holding stick (magnetic)” to retain the tappets in position.

The valve tip clearance between valve tip and the rocker should be0.012 inch (0.30 mm) when the engine is cold or hot

When adjusting this clearance tighten locknut effectively. so that it does not loosen in service. (Ref. Fig. E 7).

General

All setscrews of the cylinder head and top face of the cylinder block should be examined for looseness. damaged threads etc. The cylinder head setscrews should also be examined to ensure the threads are not damaged/elongated.

NOTE : *All the setscrews should be replaced at the third attempt.*

All joint faces should be examined for pitting and defacement.

Wash out and thoroughly clean the coolant passages in the head subsequently drying out and finally cleaning with compressed air.

If the coolant jacket of the cylinder head shows signs of excessive scale a proprietary brand of descaling solution should be used.

If possible the cylinder head should be coolant tested for leaks with warm coolant at a coolant pressure of 4 bar (60 psi) for 1 minute.

IMPORTANT

The relative valve head depth however must afterwards be checked and if necessary corrected to

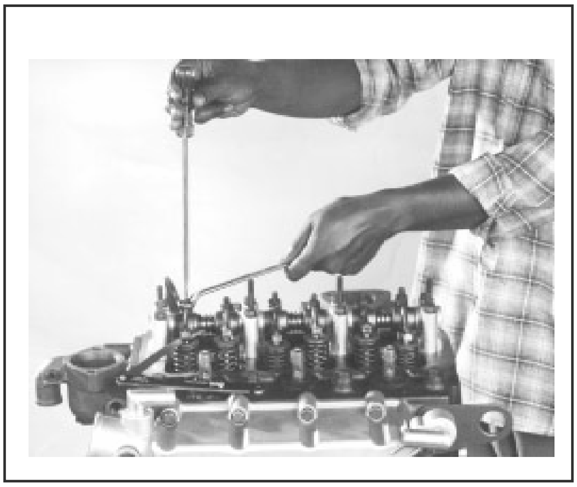


Fig. E 7 – Adjusting Valve Tip Clearance

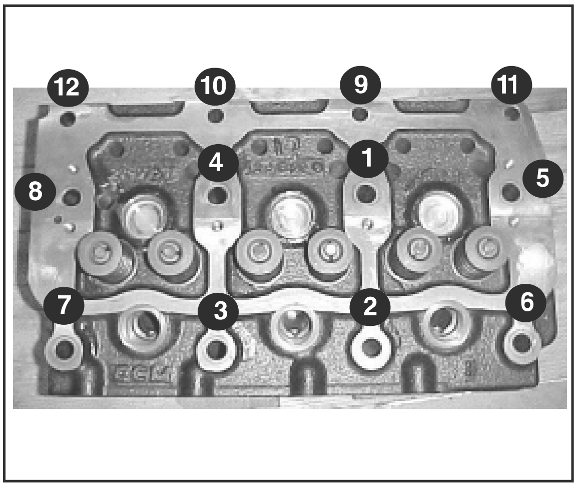


Fig. E 8 – Cylinder Head Tightening Sequence

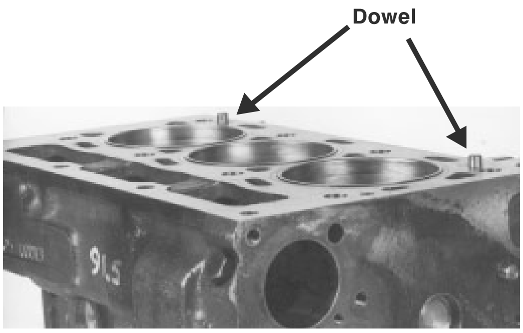


Fig. E 9 – Head Gasket Locating Dowel

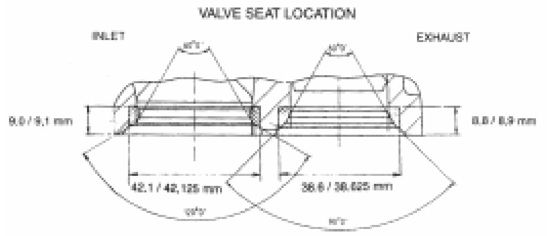


Fig. E 10 – Valve Seat Insert Location

conform with the limits quoted on section B.

Re-assembly and Replacing

Replace valves. washer. spring. collars and collets. taking care that the numbers on the valves correspond to the numbers stamped adjacent to the valve seats. (if Stamped)

On these engines one spring is fitted to each valve with a spring seating washer.

Before replacing the cylinder head it is extremely important to ensure that the faces of the cylinder block and cylinder head are perfectly clean.

A new cylinder head gasket should be used. The gasket is marked ‘Front Top’ to indicate how it should be fitted. Locating dowls are provided on cylinder block top surface

Non-retorque type gasket is being used. It should be fitted dry. This gasket does not require retorquing in Post-Delivery inspection.

When the underface of the cylinder head is perfectly clean. the head may be lowered into position on the locating dowels and the setscrews pulled down in the order shown in Fig E8. The cylinder head setscrews should be pulled down in stages according to torque and in the order .

Replace atomisers.

Replace the push rods. rocker shaft assembly. but before tightening the securing setscrews the rockershaft should be set so as to ensure locating the shaft (Ref. Fig. E1) by the four studs provided for rocker cover.

When the rocker shaft is correctly positioned. tighten the securing setscrews and set the valve tip clearance to 0.012 inch (0.30 mm). (cold or hot)

Provision is made in the cylinder head coolant outlet for the housing of a thermostat or blanking sleeve which must be fitted.

Adjusting Valve Tip Clearance

The three throw 120° crankshaft makes it necessary to adopt a slightly different sequence for tappet adjustment to the normally accepted procedure for four and six cylinder engines.

Valve tip clearances for both inlet and exhaust should be set to 0.012 inch (0.30 mm) in cold or hot.

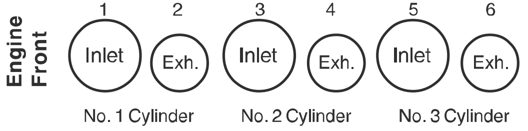
To adjust valve tip clearance on engine proceed as follows:-

(a) Rotate the crankshaft in clockwise direction and bring No. 3 Cylinder exhaust valve to full open position and set the valve tip clearance for No. 1 Cylinder inlet and exhaust valves. (*At this position No. 1 piston is at the end of compression stroke).*

(b) Then rotate the crankshaft in the same direction and bring No. 1 Cylinder exhaust valve to full open position and set the valve tip clearance for No. 2 Cylinder inlet and exhaust valves. *(At this position No. 2 piston is at the end of compression stroke).*

(c) Again rotate the crankshaft in the clockwise direction and bring No. 2 Cylinder exhaust valve to full open position and set the valve tip clearance for No. 3 Cylinder inlet and exhaust valves. *(At this position No. 3 piston is at the end of compression stroke).*

Valve layout :



Section F

PISTONS AND CONNECTING RODS

PISTONS AND CONNECTING RODS

The pistons are of special light aluminium alloy with a re-entrant bowl in the crown (Fig. F1). They are secured to the connecting rods by means of fully floating gudgeon pins which work in thin wall steel backed lead bronze lined bushes fitted in the small ends of the connecting rods. Circlips are provided in the pistons to secure the gudgeon pins in position. Three piston rings are fitted to each piston. All the piston rings are fitted above the gudgeon pin.

The connecting rod big ends are split at right angles to the axis of the rods. the caps being secured by two bolts and nuts.

Always ensure that big end nuts are replaced by new. once they are removed.

The big end bearings are of the thin wall type consisting of a thin steel shell lined with aluminium tin.

Ensure correct replacement of the pistons number 1 being at the front of the engine.

The connecting rods and caps. are also marked. On one side they are stamped with a number corresponding to their position in the engine.

To Remove Pistons and Connecting Rods

1. Remove cylinder head assembly (Ref. Section E).
2. Drain oil and remove sump
3. Turn the engine until number one connecting rod is at bottom center. Remove bolts and nuts securing the connecting rod cap.
4. Remove the connecting rod cap and both top and bottom half bearing shells.
5. The piston and connecting rod can then be pushed out of the top of the cylinder block.
6. Continue operations until all three pistons and connecting rods have been removed.
7. Keep all pistons connecting rods caps bearing shells bolts and nuts together as separate assemblies. each to each as marked.

To Remove Gudgeon Pins

Remove the circlips from the pistons using a pair of long nose pliers.

The gudgeon pins can now be removed and the connecting rods separated from the pistons.

To Fit New Small End Bushes

The small end bushes are a press fit in the connecting rods.

Press out the old bushes using a suitable press.

Remove any sharp edges around the connecting rod small end parent bores.

Press in the new bushes using a suitable dolly at the same time ensuring that the oil holes in the bushes coincide with the holes in the top of the connecting rods.

Ream out the new bushes in to suit their respective gudgeon pins and check for parallelism and twist.

To Assemble Pistons and Connecting Rods

If the original pistons are to be used again they should be re-assembled to their respective connecting rods. i.e. the piston stamped No.1should be fitted to the connecting rod stamped No. 1.

Pistons for the SJ 327E engine should be fitted with the offset of combustion bowl in the crown towards fuel injection pump side. (Offset of valve packets towards camshaft side).

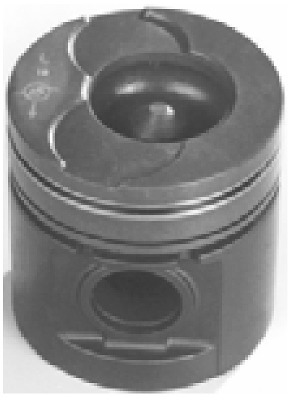


Fig. F 1 – Piston

Assemble the connecting rod to the pistons and insert the gudgeon pin.

Fit the circlips to the piston. It is difficult to advise as to when new circlips should be fitted but in the event of an engine being in service for a lengthy period it is advisable that new circlips be used during re-assembly.

Fitting New Rings

The piston and rings should be thoroughly washed to remove any oil and grease.

Check piston rings for correct gap (Ref. Section B)

In worn cylinder bores the gaps should be checked at the unworn top of the bore. *after any carbon has been removed.*

Fit the rings to the piston in the following position (reading from the top of the piston).

1. Ring compression (Chromium inlaid. Half Keystone with 'Top' marked).
2. Ring compression (Cast Iron Taper land with 'Top' marked).
3. Conformable oil control Ring

When fitting new rings to original pistons clean out the piston ring grooves.

The pistons should be carefully examined for bruising of the ring grooves and to ensure that the rings move truly in their grooves. In addition the piston skirt should be examined and if there is any scoring the piston must not be used again.

To Fit Conformable oil Ring

1. Fit the helical coil spring onto the 3rd groove of the piston.
2. Insert the latch into the coil spring aligning both the ends.
3. Fit the outer C.I. ring over the coil spring Ensure coil spring gets seated properlyinside the ring groove.
4. Also ensure the coil spring latch is on the opposite side of the ring open end gap.

To Replace Pistons and Connecting Rods

Connecting rods and caps are plainly marked to indicate their original position in the engine. The numbers are stamped on that side of the connecting rod and cap which is machined to take the locating lips of the big end bearings.

Before fitting pistons. the cylinder bores should be given a liberal coating of clean lubricating oil.

When fitting pistons and connecting rods to the cylinder block and crankshaft ensure that the side of the connecting rod which is stamped with the number goes to the fuel pump side of the engine.

For SJ327 E engines ensure that the words "F" marked on the piston crown is towards the front of the engine. (Offset of combustion bowl in the crown toward fuel injection pump side).

Insert the pistons and connecting rods into the cylinder bores from the top. ensuring the piston and rod stamped No. 1 are fitted into No. 1 bore and No. 2 into No. 2 bore and so on commencing from the front of the engine.

To minimise the possibility of breaking piston rings it is advisable to use a piston guide. Take care not to damage the rings. Should the piston accidently drop partly into the cylinder bore and is held suspended by a piston ring it must be taken out again and the ring examined to see if it is cracked or broken.

Turn the crankshaft until the appropriate crankpin is at bottom center pull the connecting rod to the crankpin and insert the half bearing.

Fit the cap and cap half bearing ensuring that the markings on connecting rod and cap coincide.

The nuts used on the big end bolts should not be used a second time but should be replaced by new wheneverthey are removed.

Tighten the connecting rod nuts using a torque wrench set to the tension given on Section B.

Rotate crankshaft by hand and note that all parts move freely.

Check the piston height in relation to the top face of the cylinder as described below.

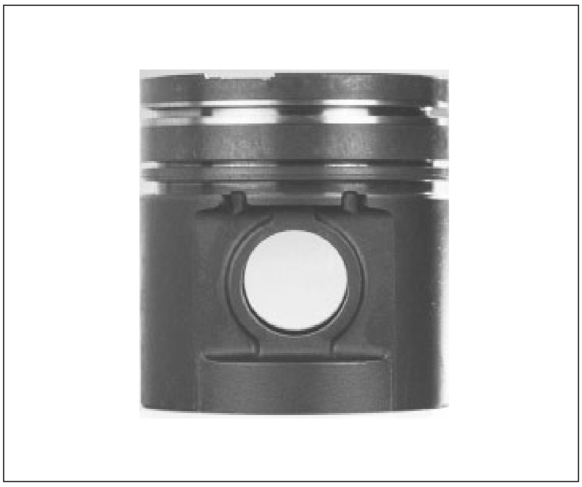


Fig. F 2 – Piston Ring Groove

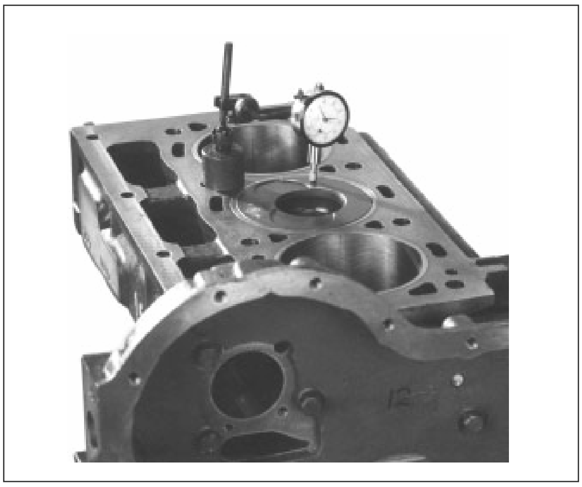


Fig. F 3 – Piston Height Measurement

Fitting New Pistons

An important point to note is that when the crankpin is at top dead center the crown of the piston must be 0.0059/0.0023 inch (0.150 / 0.060 mm) above block surface.

Pretopped pistons are being used with letter “L” or “H” marked on piston crown for identification

“L” – Low grade / “H” – High grade.

(Note : This grade does not refer to material grade.)

To determine the piston level. the piston assembly and connecting rod should be fitted to the cylinder block and crankshaft as previously described.

When assembled. turn the crankshaft to bring the piston to T.D.C. and check the distance between the piston crown and the top face of the cylinder block as shown in Fig. F.3.

Carry out this operation with each new piston in turn. If necessary it has to be replaced by another new piston. The piston should not be machined for any reason in an attempt to correct this height.

The distance between the cylinder block face and piston crown should now be checked to ensure the limit has been maintained when the piston is at Top Dead Center (TDC).

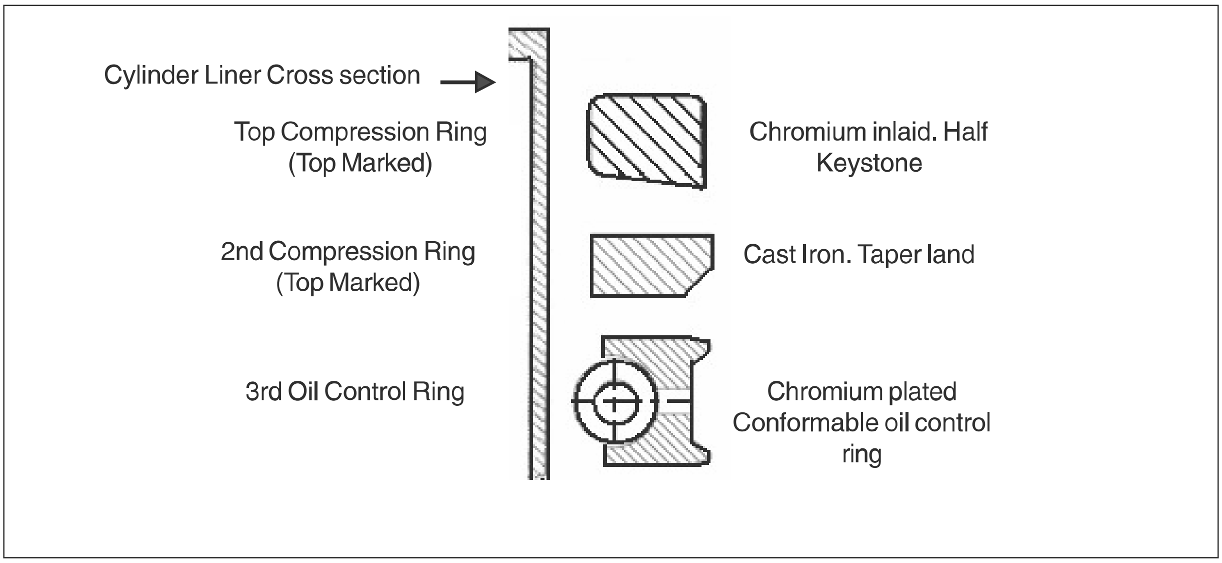

Cylinder Liner Cross section
Top Compression Ring (Top Marked)
Chromium inlaid. Half Keystone
2nd Compression Ring (Top Marked)
Cast Iron. Taper land
3rd Oil Control Ring
Chromium plated Conformable oil control ring

Fig. F 4 – Ring Layout

Section G

CYLINDER BLOCK AND LINERS

CYLINDER BLOCK AND LINERS

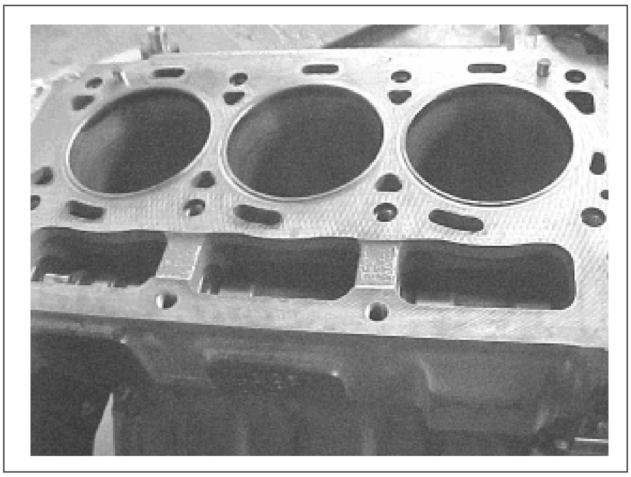


Fig. G 1 – Cylinder Block with Liner (SJ 327 E)

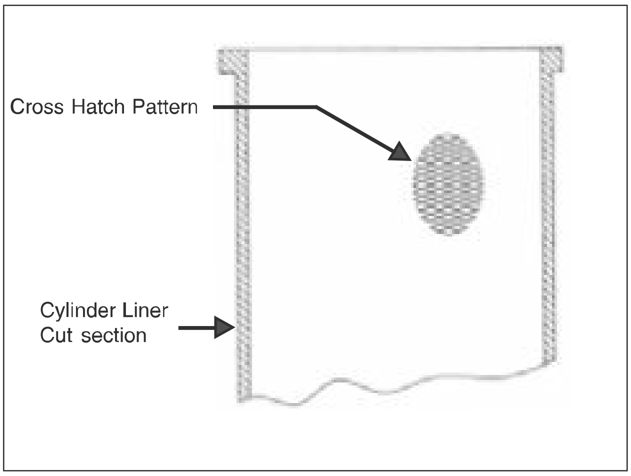


Fig. G 2 – Cylinder Liner / Hatch Pattern

The cylinder block is fitted with renewable thin wall cast iron dry cylinder liners. The cast iron cylinder liners are an interference fit and require boring and honing to size after fitting. The liner without flame ring is applicable to SJ 327E engines as shown in figures G1 / G2. The cylinder head gasket is non-retorque type.

Cylinder liners fitted to SJ327 Eengines are **not recommended to rebore.** When they are worn to an extent whereby engine performance is affected. they should be renewed.

To Remove Liners

1. Remove cylinder head as detailed in Section E.
2. Remove the piston and connecting rod assemblies crankshaft and all component parts of the cylinder block as detailed in the appropriate sections of this manual.
3. Press or draw the liners out through the top of the cylinder block ensuring no damage is done to the parent bores (cast iron production liners are an interference fit and should be removed with a heavy duty press).

Preparation for Fitting New Liners

Great care must be taken in handling. transit and storage of new liners.

After removal of the old liners. the parent bore must be thoroughly cleaned both in the top recess of the liner flange and in the parent bore itself.

A check must be made to ensure that the whole areas of contact with the liners in the cylinder block are free from burrs. corrosion or damage. Remove any burrs present.

Ensure that the new liner is thoroughly clean before fitting. If cleaning fluid is used to wash the liner. it is important that the liner be thoroughly dried and well oiled before fitting.

Throughout the whole operation extreme cleanliness is essential as the entry of the smallest particle of grit or other foreign matter is sufficient to cause local distortion of the liner bore.

To Fit New Liners (Per finished Liners)

1. Lubricate the outside diameter of the liners with clean oil which should be applied by means of a pressure can. The use of a brush is not recommended.
2. Press or draw in the new liners using a suitable shouldered metal disc ensuring that the flanges at the top of the liners do not foul the counter-bore at the top of the parent bore thus causing distortion at the top of the internal diameter of the liner.

When fully seated the top face of the liner flange should be 0.0031 / 0.0011 inch (0.080/0.030 mm) above the top face of the cylinder block. (Ref. Fig. G3).

Pre finished liners (as used in factory production) are an interference fit in the cylinder block as compared with the transitional fit of pre-finished liners and require

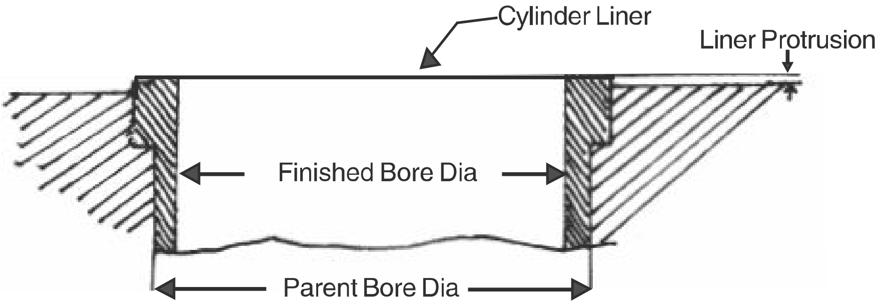

Cylinder Liner
Liner Protrusion
Finished Bore Dia
Parent Bore Dia

Fig. G 3 – Cylinder Block / Liner

to a diameter of 3.741 / 3.740 inch (95.022 / 95.00 mm) for SJ 327 E engines.

Each new liner should be checked in three positionstop center and bottom; the readings being taken transversely and parallel to the center line of the cylinder block at each position.

Having fitted the new liners the remainder of the re-assembly operations are a reversal of the removal procedure.

Section H

CRANKSHAFT AND MAIN BEARINGS

CRANKSHAFT AND MAIN BEARINGS

The crankshaft runs in four pre-finished re-placeable shell bearings lined with aluminium tin.

The crankshaft is fitted with two cast iron counter weights. one at the front crank web and one at the rear crank web to give full rotating balance.

The main bearings are located in position by tabs fitting into slots machined in the bearing housings.

The seal at the rear end of the crankshaft is a cassette type seal fitted in a one-piece housing

Fitting New Main Bearings and Thrust Washers

Under normal circumstances. by the time the main bearings and thrust washers require renewing the crankshaft will need to be removed for regrinding. However if for any reason one or more of the bearings or thrust washers have to be renewed or removed for inspection. this can be carried out without removing the crankshaft from the engine.

1. To remove a main bearing take off the cap of the bearing in position. For the rear main bearing cap. see (1) in next column.
2. Do not remove more than one bearing cap at a time.
3. Loosen the remaining bearing cap setscrews one or two turns.
4. Remove the lower half of the bearing from the bearing cap.
5. With a suitable piece of wood push out the top half of the bearing by rotating it on the crankshaft. applying the tool to the side opposite the bearing lip. The locating lips are on the camshaft side of the engine.
6. Inspect the bearing shells and if they require renewing insert a new half bearing in the top inserting the plain end first. Fit new half bearing to cap.
7. Replace cap and tighten setscrews lightly before proceeding to the next bearing.
8. Having replaced the bearing and caps pull down the setscrews with a torque wrench set to the tension given on Section B

The thrust washers fit in recesses provided on either side of the rear main bearing housing and cap.

1. To renew the thrust washers. remove the rear main bearing cap. Before doing this it will be necessary to release the rear end oil seal and housing
2. Remove the two bottom half thrust washers from the main bearing cap.
3. The two top half thrust washers can be removed by sliding them round from one side with a piece of wood or similar material and rotating them until they can be removed.
4. To fit new thrust washers lightly coat the two upper halves with lubricating oil and slide in the recesses provided on either side of the rear main bearing housing. The steel side or flat surface of the thrust washers should be towards the bearing housing.
5. Renew the main bearing cap "O" rings. Lightly coat around the grooves machined in the cap butt faces with jointing compound and ensure that the grooves are free of jointing compound.
6. Place the two lower halves of the thrust washers on either side of the rear main bearing cap and replace the cap.
7. The bearing cap securing setscrews should be pulled down with a torque wrench set to the tension given on Section B Check crankshaft end float.
8. Refit the rear end oil seal housing and then cassette type seal using special tool.

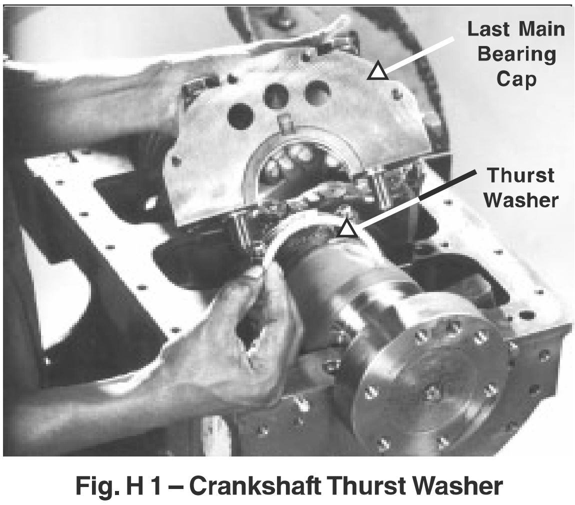


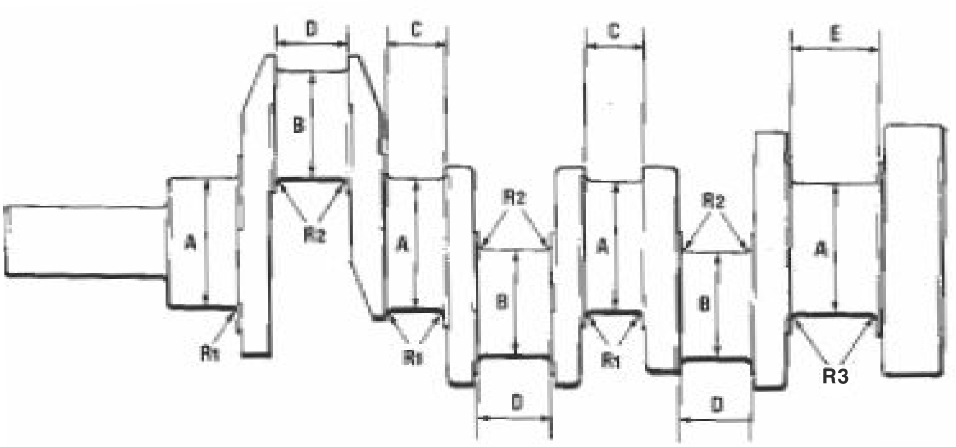
Fig. H 1 – Crankshaft Thurst Washer

To Remove Crankshaft

1. Remove sump and lubricating oil pump (Ref. Section L).
2. Remove water pump (Ref. Section M).
3. Remove crankshaft pulley.
4. Take off timing case front cover and remove idler gear.
5. Remove starter motor. flywheel & flywheel housing. When removing the flywheel. fit two guide studs in the crankshaft flange for support.
6. Remove connecting rod caps and big-end bearings.
7. Remove the rear end oil seal and housing.
8. Remove setscrews and remove main bearing caps and half bearings.
9. Lift out crankshaft.

Should it be necessary to replace the crank-shaft gear. it should be ascertained that the scribed timing mark is to the front when the gear is fitted. The distance piece between the gear and the crankshaft should be fitted with the chamfer to the inside.

If the main bearings are to be used again they should be suitably marked so that they may be installed in the same position from which they were removed.



	0.0098 inch (0.25 mm) **Undersize**	0.020 (0.51 mm) **Undersize**	0.0299 inch (0.76 mm) **Undersize**
A.	69.56/69.58 mm	69.30/69.32 mm	69.05/69.07 mm
B.	56.86/56.88 mm	56.60/56.62 mm	56.35/56.37 mm

C. 31.184 mm (maximum)

D. 40.00 mm (maximum)

E. 47.27 mm (maximum)

RI 3.18 / 3.56 mm all journals **Except Rear** – 3.97 / 4.22 mm (R3)

R2 4.76 / 5.16 mm all crank pins

Surface finish of crankpins. journals and fillet radii 0.4 / 0.2 microns C.L.A.

Fig. H2 – Crankshaft

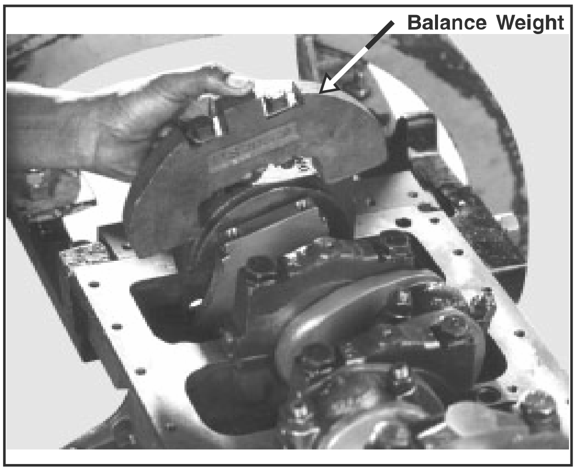


Fig. H 3 – Balance Weight

Balance Weights

Should it at any time be necessary to replace crankshaft balance weights these are normally supplied in wired pairs and must be fitted as a pair. Should a single balance weight require replacing this must be done selectively so that there is no greater weight variation than 1 oz (0.028 Kg.) between individual weights. (Ref. Fig. H3)

Regrinding the Crankshaft

Before proceeding to regrind the crankshaft. the following points should be checked to ensure it is suitable for further machining.

(a) The crankshaft should be crack-detected before regrinding. It must of course be remembered to demagnetise the crankshaft after crack-detecting. in order to remove any polarisation which may be present.

(b) The main journal and crankpin diameters should be checked to ascertain the next appropriate under size to which the crankshaft can be-reground i.e. 0.0098 inch (0.25 mm), 0.020 (0.51 mm) , 0.0299 inch (0.76 mm) (Ref. Fig H 2).

If the crankshaft requires to be reground below 0.76 mm it is recommended that a new crankshaft is fitted.

During regrinding. all the limits must be adhered to. and the main journals and crankpins must be free from grinding marks.

NOTE: *It is important that the RADII on the main journals and crankpins are maintained. If these are neglected. a fatigue fracture is liable to occur.*

After regrinding. the sharp corners on the oil holes should be removed and the crankshaft crack-detected again and demagnetised.

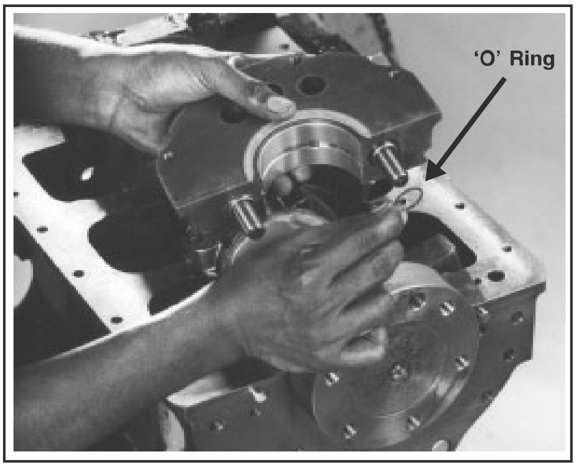


Fig. H 4 – Main Bearing Cap 'O' Ring

Replacing Crankshaft

1. Ensure that all oil-ways are clear.
2. Check main bearing setscrews for stretch or damage to threads. Affected setscrews must be scrapped.

   In no case should setscrews other than those supplied by the engine manufacturer be used as they are of special heat treated highgrade steel.
3. Clean bearing housing and place top half bearing in position.
4. Place crankshaft in position.
5. Lightly smear the two upper thrust washers with lubricating oil and slide in to the recesses provided on either side of the rear main bearing housing. with the steel side or plain surface of the washers towards the housing. (Ref. Fig. H1)
6. Fit lower halves of main bearings to bearing caps and place in position ensuring that the thrust washers on No. 4 main bearing cap are fitted correctly.
7. Renew the rear main bearing cap "O" rings (Fig. H 4).
8. Lightly coat the rear main bearing cap butt faces with Jointing Compound. only coat outboard of the grooves machined in the cap butt faces and ensure that the grooves are free from jointing compound.
9. When replacing the main bearing caps. ensure that they are fitted in their respective positions. also that they are fitted the correct way round. The caps are numbered. No. 1 commencing at the front of the engine. Each cap is also marked with a serial number and when fitted. this number should read in line with the serial number stamped on the cylinder block bottom face.

Crank shaft Rear end Oil seal Cassette

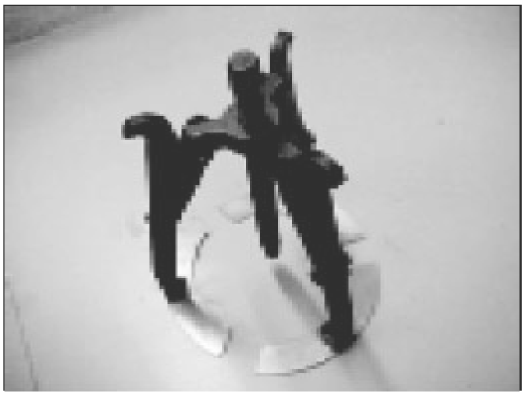


Fig. H 5

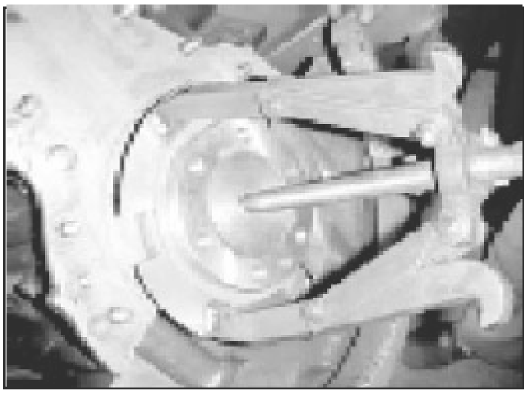


Fig. H 6

For final tightening of the setscrews, a torque wrench should be used, set to the tension given on Section B

When refitting the crankshaft pulley, ensure that the pulley setscrew is tightened to the correct torque as given on Section B .

Re-assemble engine as required and to the instructions given for the various operations.

Cassette Type Rear end Oil Seal :

It provides a sealing system by unitizing bonded PTFE wafer type sealing lip with a steel flanged (wear) sleeve.

Removal Procedure :

- Loosen all the fixing bolts of the rear end oil seal retainer (Seal Housing).
- Unscrew all the fixing bolts and remove the retainer (Seal Housing).
- Position the 3 jaws / split rings of the removal tool over the groove / flange of the oil seal – Ref. Fig. H5
- Adjust the central screw (removal screw) in such a way that the tip rests against the center of the crankshaft flange.
- Ensure that the jaws / split rings are properly positioned so that it does not slip out of position while removing the oil seal – Ref. Fig. H6.
- Drive the removal screw forward so as to pull the oil seal gradually.
- Take out the removal tool.
- Oil seal removal is complete

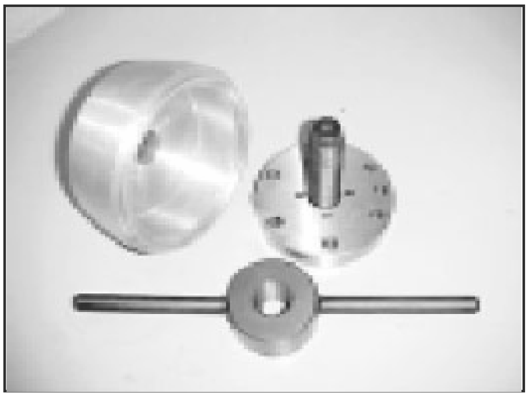


Fig. H 7

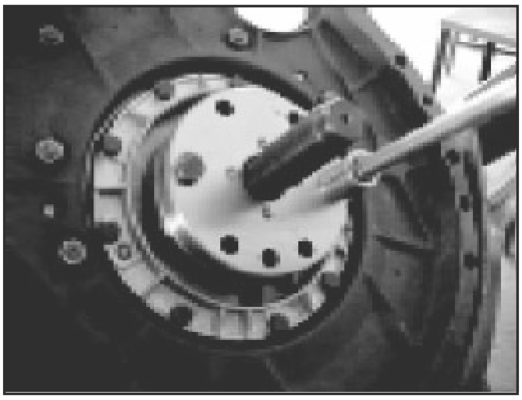


Fig. H 8

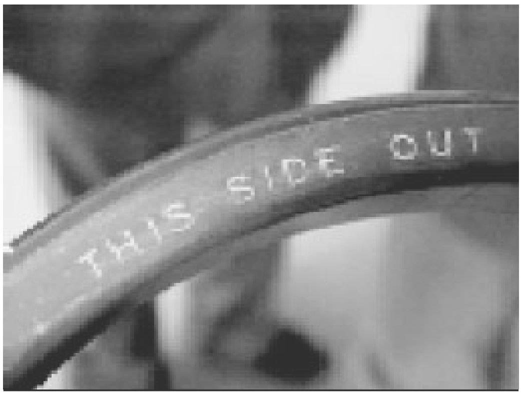


Fig. H 9

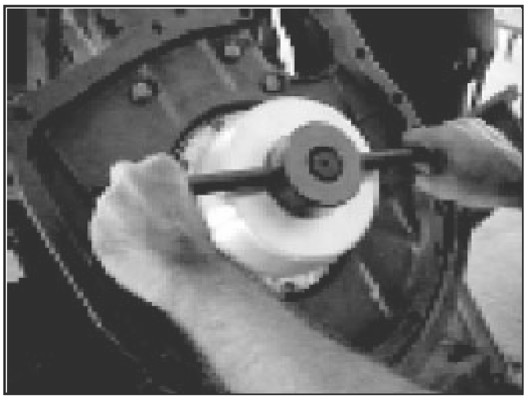


Fig. H 10

Fitment Pocedure :

- Check for crankshaft end float.
- Assemble rear end oil seal retainer housing to Pt. No. : 37424611 onto the cylinder block rear face with joint and tighten all bolts as per sequence (Torque 20 lbf.ft or 27 Nm) using a torque wrench.
- Ensure proper torque tightening on all the bolts
- Check the bore of the oil seal retainer housing and crankshaft sealing surfaces. Remove any surface burr, dust, dirt or metal chips before seal installation.
- Verify that the oil seal and installation tool are available and are in good and clean condition.
- Dismantle installation tool (Ref. Fig.H7).
- Position the adaptor plate and mount it on the crankshaft palm face using two screws and tighten the screws (Ref. Fig. H8).
- Apply molykote – 111 compound uniformly on the OD of the crankshaft flange and ID of the oil seal.
- Position the new oil seal over the adaptor. (Seal surface with the part number identification should be positioned towards the operator Ref. Fig. H9).
- Position the installer plate over the oil seal (Ref. Fig. H10)
- Position the Hexagonal nut over the adaptor plate stud and drive the same until the installer plate bottoms out on the seal retainer housing face (Ref. Fig. H10).
- Remove the Hexagonal nut, installer plate and adaptor plate.
- The seal installation is now complete.

Section J

TIMING CASE AND DRIVE

CONTENTS

Section	Description		Page No.
A	ENGINE NUMBER LOCATION	...	6B - 3
	EPA STICKER LOCATION	...	6B - 4
	THREADS	...	6B - 5
B	TECHNICAL DATA	...	6B - 7
	MANUFACTURING DATA AND DIMENSIONS	...	6B - 9
C	OPERATING AND MAINTENANCE	...	6B - 18
D	FAULT FINDING CHART	...	6B - 24
E	CYLINDER HEAD	...	6B - 36
F	PISTONS AND CONNECTING RODS	...	6B - 41
G	CYLINDER BLOCK AND LINERS	...	6B - 45
H	CRANKSHAFT AND MAIN BEARINGS	...	6B - 48
J	TIMING CASE AND DRIVE	...	6B - 54
K	TIMING	...	6B - 61
	FUEL INJECTION PUMP CALIBRATION CHART	...	6B - 63
L	LUBRICATING SYSTEM	...	6B - 67
M	COOLING SYSTEM	...	6B - 73
N	FUEL SYSTEM AND AIR CLEANERS	...	6B - 76
P	FLY WHEEL AND FLY WHEEL HOUSING	...	6B - 81
Q	APPROVED LUBRICATING OILS	...	6B - 83

Appendix - I ... 6B - 84

TIMING CASE AND DRIVE

The camshaft is carried high up on the off side of the cylinder block.

It is driven from the front of the crankshaft by means of gears.

The timing gears are enclosed by a Cast Iron/Timing case and Aluminium timing cover.

To Remove the Timing Case Cover

1. Loosen the alternator mounting bolts and remove the fan belt.
2. Loosen off the hose clamps on the hoses fitted to the water pump and remove the water pump.
3. Remove the setscrew of crankpulley and washer, the setscrew is of a normal right hand thread into the crankshaft.
4. Remove the crankshaft pulley.
5. Remove the alternator
6. Remove the brackets and adjustable linkage.
7. Remove the timing case cover setscrews Two long bolts pass through the timing case to secure a cover at the rear of the timing case, blanking off the power take off bore.
8. Remove the timing case cover taking care not to damage the crankshaft front oil seal which is located in the timing case cover.

To Renew the Crankshaft Front Oil Seal

1. Carefully extract the oil seal from the timing case cover using a suitable press.
2. Locate a new seal in the timing case cover with the lip of the seal towards the inside of the cover.
3. Seals encased with a metal rim should be coated with jointing compound before being pressed into the timing case cover bore.
4. Press the new seal in position using a suitable dolly to ensure the seal is square in the bore of the cover.

To Replace the Timing Case Cover

1. Clean the jointing faces of the timing case and its cover using a new joint, refit the cover and water pump taking care not to damage the front crankshaft oil seal as the cover is placed over the crankshaft front end.
2. For purposes of centralizing the cover around the crankshaft, fit the pulley to the crankshaft and fix the position of the cover to the timing case by two or three setscrews. Remove the pulley and refit all the setscrews to the timing case (Centralising tool could be used instead of crankpulley).
3. Replace the crankshaft pulley, washer and dognut or setscrew.
4. Refit the hoses to the water pump and tighten the clamps.
5. Replace the alternator bracket, alternator and fan belt and tighten the alternator retaining bolts.

Timing Gears

The camshaft and the fuel pump gears are driven by the crankshaft gear through two idler gears mounted on hubs, bolted to the front of the cylinder block. All the gears are suitably marked during production to facilitate retiming the marks being in line when No. 1 piston is at top dead center on its compression stroke (Ref. Fig. J4). It will be appreciated that these timing marks will not align at every rotation of the crankshaft where No.1 piston is at T.D.C. compression.

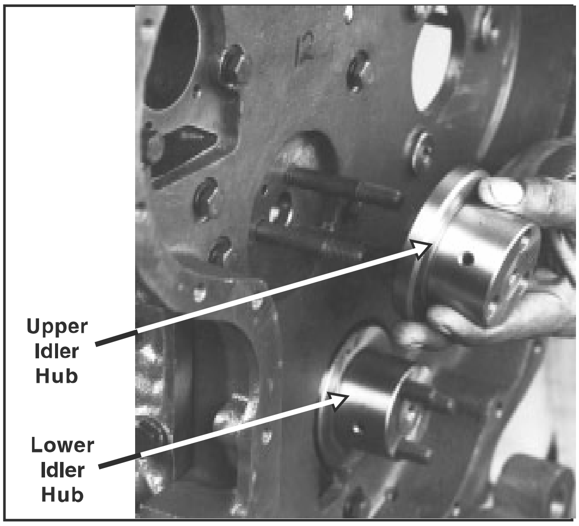


Fig. J 1 – Timing Case, Idler Hub

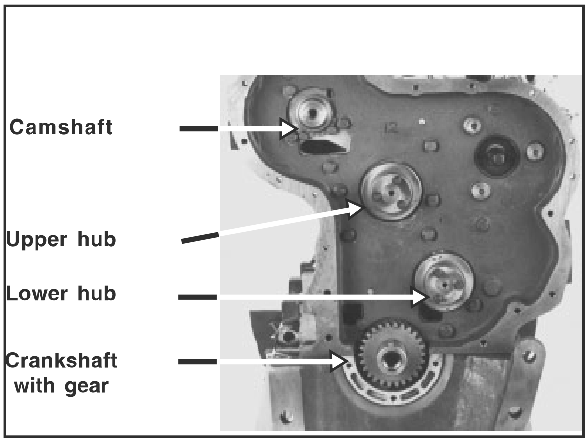


Fig. J 2 – Timing Case without gears

If it is necessary to replace any of the timing gears, ensure that there is a minimum backlash of 0.0031 inch (0.08 mm) (Ref. Fig. J4).

The backlash between the crankshaft gear and oil pump idler gear should be 0.0074 / 0.0125 inch (0.19 to 0.32 mm) (Ref. Fig. J5).

To Remove the Idler Gears and Hubs

1. Remove the banjo bolt securing the oil pipe to the lower idler gear hub.
2. Release the banjo bolt and remove the oil pipe by withdrawing it from the back of the timing case.
3. Knock back the tab washers and remove the three securing nuts.
4. Remove the locking washer and idler gear retaining plate.
5. Remove the lower idler gear.
6. Remove the upper idler gear in the similar manner.
7. The idler gear hubs may now be removed from the studs located in the front of the cylinder block (Ref. Fig. J1).
8. Where necessary, replace idler gear bushes (if fitted). These should be finished by boring to 1.999 / 2.0007 inch (50,79 / 50,82 mm) and faced to 1.1865 / 1.1857 inch (30,137/30,163 mm) overall width.

To Replace the Idler Gears and Hubs

1. The studs on which the hubs locate, are so positioned that the hubs will fit in one position only and the boss at the rear of the hub locates in the machined face of the cylinder block. Fit the lower and upper idler gear hubs which are interchangeable.

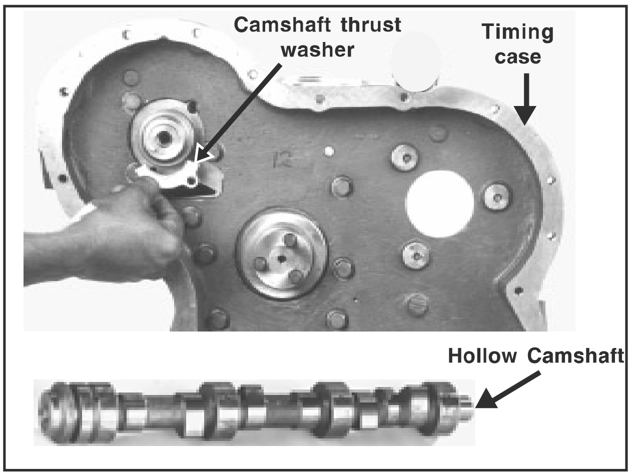


Fig. J 3 – Camshaft / Thrust washer

2. Remove the rocker cover and release the rocker assembly.
3. Turn the crankshaft and bring No. 1 piston to T.D.C. i.e. with the key-way at the front of the crankshaft uppermost.
4. Replace the two idler gear ensuring that all timing marks align.
5. Replace the idler gear retaining plates, which will only fit in one position on the studs. The lower retaining plate has a hole to take the oil pipe banjo bolt.
6. Fit new locking washers and replace the securing nuts. Bend the tab washers to lock the nuts.
7. Replace the oil pipe and banjo bolt to the lower idler gear retaining plate. The closed end of the oil pipe must locate in a hole in the back of the timing case immediately above its lower idler gear.
8. Secure the rocker assembly, adjust the valve tip clearance and fit the rocker cover.

To Remove the Camshaft Gear

1. Release and remove the 12 mm securing setscrew from the camshaft.
2. The camshaft gear may now be removed from the camshaft

To Replace Camshaft Gear

1. Remove upper idler gear and release the rocker assembly to facilitate turning of camshaft. On the spigot of the camshaft is a dowel pin ,ensure that it aligns with the dowel hole in the cam shaft gear.
2. Replace and secure the camshaft setscrew using torque wrench.
3. Fit idler gear, aligning all timing marks and secure the rocker assembly and reset valve tip clearance.

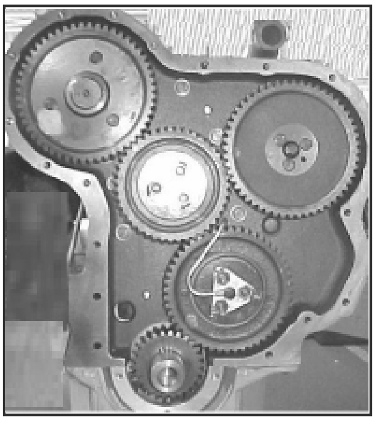


Fig. J 4 – Timing gears

To Remove the Fuel Pump Gear

1. Remove the idler gear.
2. Release and remove fuel pump gear securing nuts.
3. Remove fuel pump gear, taking care not to damage the dowel.

To Remove the Camshaft

1. Remove the rocker shaft assembly as previously described.
2. Remove the timing case cover as previously detailed.
3. Turn the crankshaft until all the timing marks are aligned.
4. Lift all the tappets and keep them in lift position using tappets holding sticks, remove the camshaft gear and remove the camshaft thrust washer and gear from its location in the cylinder block taking care not to damage the journals, cams and tappets.

To Replace the Camshaft

1. Lift all the tappets and keep them in lift position using tappet holding sticks and carefully fit the camshaft and gear continually turning the camshaft. Take care not to damage the journals, cams and tappets. Fit camshaft thrust washer. Make sure the timing marks on the idler gear and camshaft are aligned correctly.
2. Replace timing case cover.
3. Refit the rocker shaft assembly with push rod and reset valve tip clearance.
4. Replace cylinder head cover.

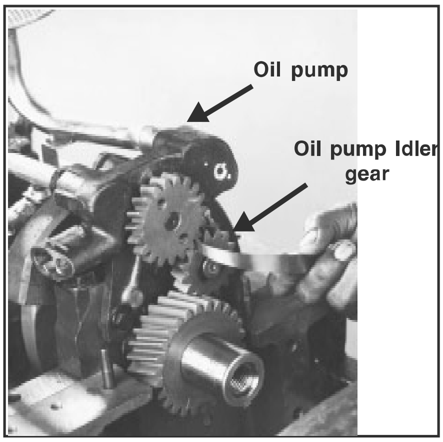


Fig. J 5 – Oil Pump gear backlash

Camshaft Thrust

The camshaft end float is taken up by camshaft thrust washer (sintered) which is retained by two setscrews (Ref. Fig. J3).

To Remove the Timing Case

1. Remove the timing case cover as previously detailed.
2. Release and remove the rocker shaft assembly.
3. Remove the sump as explained under “Lubricating System” (Section L).
4. Remove timing case bottom cover.
5. Release the banjo bolt fitted on lower idler hub and remove the oil pipe by withdrawing it from its locating hole in the back of the timing case.
6. Unscrew the retaining setscrew and remove the locking washer, idler gear and spigot.
7. Lift all the tappets and keep them in lift position using tappet holding sticks and remove the camshaft gear, thrust washer and camshaft taking care not to damage the cams or bearing journals.
8. Release the three setscrews and remove the driving gear from the fuel pump.
9. Remove all cables and pipes from the fuel injection pump. When removing the high pressure pipes from the pump, release the pipes at the atomiser end and remove the pipes.
10. Unscrew and release the three nuts, spring washers and plain washers securing the fuel pump flange to the timing case and remove the fuel injection pump. Ensure that all inlet and outlet connections of the fuel injection system are effectively sealed against the ingress of dust and dirt by the use of suitable caps and plugs.

11. Remove the setscrews and washers securing the timing case to the block and with a light tap remove the timing case from the cylinder block.

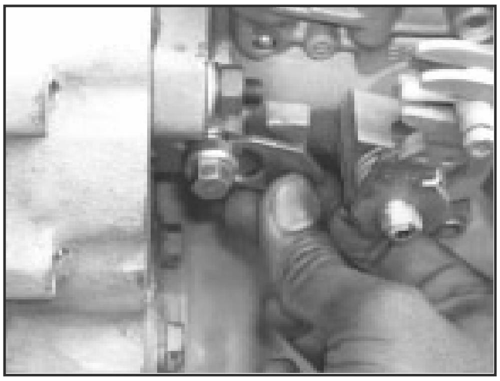
To Replace the Timing Case

1. Fit a new gasket to the cylinder block front face and replace the timing case.
2. Replace timing case bottom cover ensuring it is correctly aligned with the front face of the timing case.
3. Secure the fuel injection pump to the back of the timing case matching the scribed marks (if provided)
4. Turn the engine crankshaft until No. 1 piston is at top dead center (key on the front of the crankshaft vertically upwards)
5. Fit the fuel pump gear to the fuel pump, locating the dowel between the gear and fuel pump adaptor.
6. Lift all the tappets and keep them in lift position using tappet holding sticks and replace the camshaft, thrust washer and its gear.
7. Replace the idler gears on their hubs with the timing marks on the crankshaft gear, fuel pump gear, camshaft gear and idlers in line.
8. Replace the sump as described in the “Lubricating System”.
9. Replace the timing case cover.
10. Refit all fuel pipes and controls.

To Remove the Fuel Injection Pump

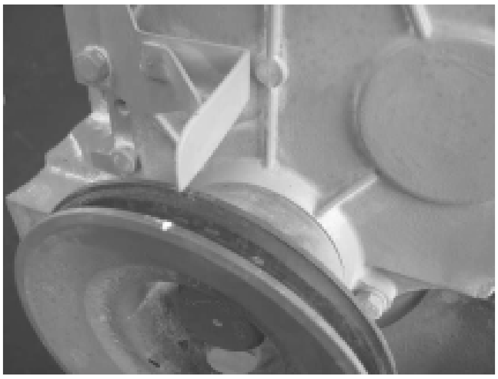
The fuel injection pump is secured to the back of the timing case on the left side of the engine and the fuel pump driving gear is securely attached to the shaft of the pump by an adaptor and three setscrews. The location of the gear to the fuel pump shaft adaptor is determined by a dowel.

On the timing case front cover is a small inspection cover and removal of this cover gives access to the setscrews securing the driving gear to the fuel pump.

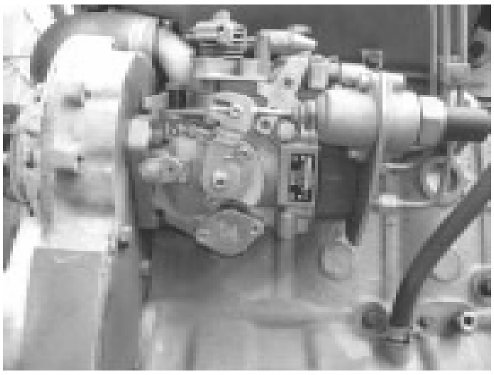


1. Lock the fuel injection pump camshaft by using pump locking screw.

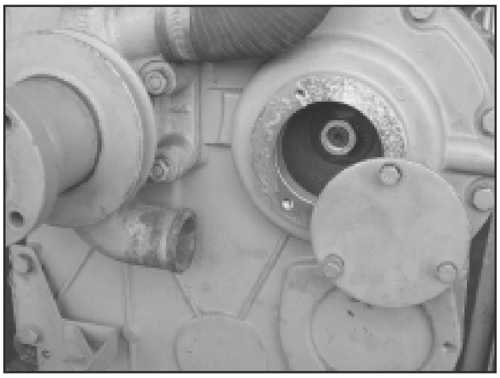
2. Rotate the crankshaft pulley and align the spill timing mark with bracket.



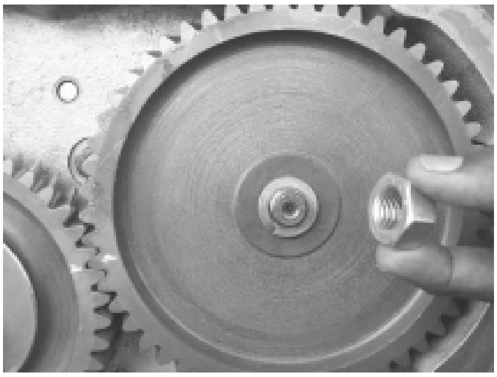
3. Remove the fuel injection pipe lines which is connected to fuel injection pump.



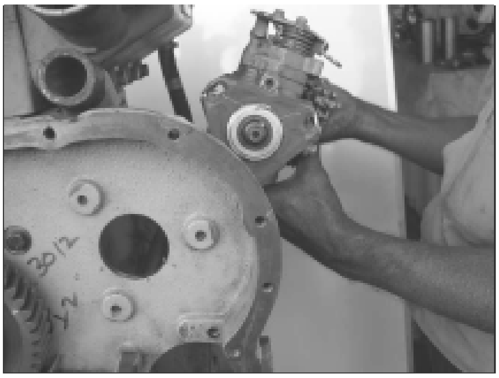
4. Remove inspection cover mounting bolts.



5. Remove the pump gear nut.



6. Remove the flange mounting nuts from the rear face of the timing case.
7. Remove the fuel injection pump from the engine.



Refitment:

8. Refit the fuel injection pump and tighten the flange mounting nuts.
9. Align the pump cam shaft gear with upper idler gear timing mark and tighten the pump gear nut to a torque of 55 lbf.ft (75 Nm).
10. Refit the timing case cover.
11. Adjust the pump timing refer section K.
12. Release the pump locking screw from the fuel injection pump.

Section K

TIMING

TIMING

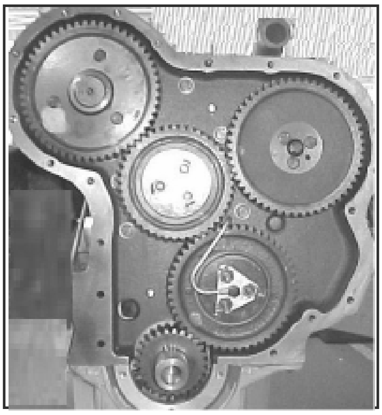


Fig. K.1 – Timing Gear Marks

The timing or the resetting of the timing can be simply and quickly carried out if the following instructions are kept in mind.

It is well to remember that the removal of the cylinder head does not in any way affect the timing of the engine.

Timing Marks

When the engine is timed at the factory, certain marks are stamped on the gears, so that if for any reason the timing must be distrubed, then the engine can easily be reset to it's original timing.

The method of marking is as follows:- With the engine timing correctly set, the engine is turned until No. 1 piston is at T.D.C. on its compression stroke. In this position, scribed lines or center punch marks are marked on the idler gear to correspond with lines or center punch marks on the camshaft, fuel pump and crankshaft gears respectively (Ref. Fig. KI).

Fuel Injection Pump Timing Marks (VE Type Pump)

Refer section K 51 for detailed setting procedure for MICO VE type pump timing.

To Reset Engine Timing

Remove atomisers.

Bring No. 1 piston to T.D.C., No. 1 piston being on its compression stroke. The T.D.C. hat has been obtained can be checked by examining the flywheel where the T.D.C. **mark should be central within the inspection opening, or the front of the crankshaft where the key for pulley should be at the top of its periphery.**

Fit the camshaft gear on locating dowel provided on camshaft hub.

Fit the fuel pump gear. This is dowelled and will only go in one position.

(Check that the fuel pump is correctly fitted to the engine and set the spill timing as recommended in Section B)

With the crankshaft gear fitted, **replace the Idler gear** ensuring the timing marks coincide (Ref. Fig. K.1).

After testing the engine, final adjustments may be necessary to find the perfect injection point. Adjustment may be made by releasing the fuel pump securing setscrews and turning the pump in the direction required.

To Check Valve Timing

Turn the engine until maximum lift is obtained on No. 3 cylinder exhaust valve. In this position, set the clearance between rocker lever and No. 1 inlet valve to 0.048 inch (1.222 mm).

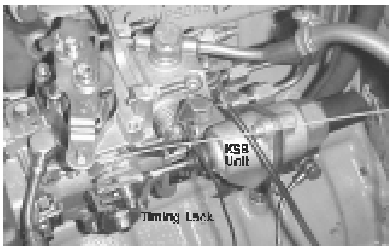
Now, turn the engine in the normal direction of rotation until the No. 1 inlet valve tip just tightens (clearance reduces to zero).

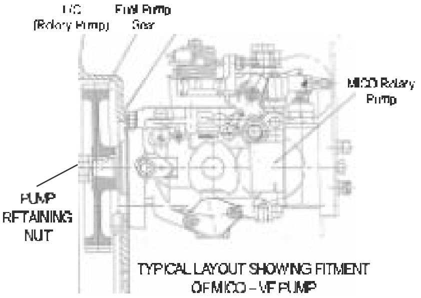
At this point, No. 1 piston should be at T.D.C. This can be checked by examining the T.D.C. provision given on the engine flywheel. A notch mark on the periphery of the crankshaft pulley has been provided and a pointer is located on the timing case cover. To set No. 1 piston to T.D.C. bring the notch mark on the pulley in line with the pointer. The ***spill timing mark*** is also provided on the periphery of the crankpulley. The tolerance for valve timing is plus or minus 2 1/2°. When the valve timing is found to be correct, adjust the valve tip clearance of No. 1 inlet valve to 0.012 inch (0.3 mm).No adjustment is provided in respect of valve timing. If the timing is found to be incorrect after the cam gear is fitted to the camshaft, then the gear may be one or more teeth out of correct mesh.

Note : *The removal of cylinder head does not in any way affect the timing of the engine.*

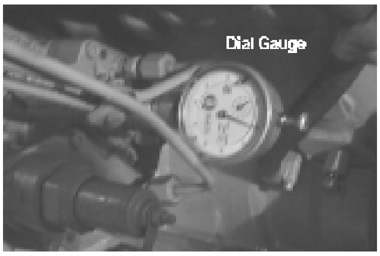
SUBJECT : **MICO VE Type Fuel Pump Timing Procedure (SJ 327E)**

Following description shows pump timing setting procedure applicable to SJ327E Engine fitted with MICO VE type fuel pump.





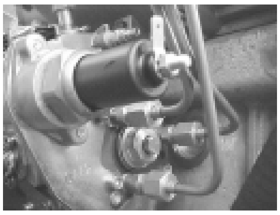
TYPICAL LAYOUT SHOWING FITMENT OF MICO – VE PUMP



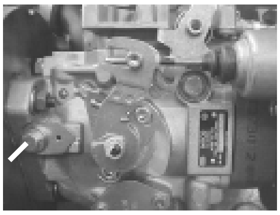
Pump Timing Setting Procedure

Recommended timing for SJ 327E engine : 0.8 mm +0 / –0.1 mm FIP plunger lift at TDC

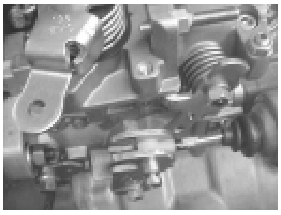
1. Rotate Crankshaft and bring number one piston to TDC position in compression stroke (Bring No. 3 Cylinder Exhaust Valve to full open position and check timing pointer matches with TDC mark on crankshaft pulley, or established TDC mark by droping any one of the valve in number **one** cylinder)
2. VE pumps are received with Timing Lock & do not release the lock until fitment.
3. Fit the pump on the engine timing case by keeping the stud in the center of the fuel pump slot on the flange.
4. Fit the fuel pump gear on the pump shaft with the key in position.
5. Ensure the timing mark on the fuel pump gear matches with upper idler gear timing mark. (applicable during reassembly).
6. Tighten the fuel pump gear retaining nut to the torque of 92.5 ± 2.5 Nm.
7. Release the lock by unscrewing the setscrew on the fuel pump body for few threads and insert the plate comes along with fuel pump and tighten the setscrew.
8. Connect 12 Volts (DC) supply to fuel pump KSB unit in fuel pump (connect positive terminal of 12 V source to KSB terminal & negative terminal of 12V source to fuel pump body) and few minutes later KSB lever will touch the stopper in fuel pump.
9. Remove the Air vent / Bleeder screw from the fuel pump distributor head.
10. Fit the dial gauge with adapter in Air vent / Bleeder screw location in fuel pump as shown in figure.
11. Turn the engine in the anticlockwise direction until the needle in the dial gauge stops moving.
12. Turn the dial to match the needle with zero reading and lock it
13. Turn the engine in clockwise direction until first cylinder comes to TDC position (as in step no. 1).
14. Note down the fuel pump plunger lift in the dial gauge. It should be within the following specification :
    0.8 mm +0 / –0.1 mm for **SJ327E engine**
15. If the value is not as per specification, loosen the fuel pump retaining (three) nuts on the timing case and swivel the fuel pump until it reaches the required specification.
16. Tighten the fuel pump retaining nuts.
17. Reconfirm the timing as per Step No. 11, 12, 13, 14 & 15.
18. Remove the dial gauge with adapter and fit back the Air vent / Bleeder screw.
19. Torque tighten the Air vent/Bleeder screw to 26 to 35 Nm.
20. Disconnect the 12 V DC source.
21. Now pump timing is completed.



KSB Terminal/Air vent screw



VE pump timing lock



KSB lever / stopper in pump

Fuel injection equipment for Simpson SJ 327 E US Tier II engine

1	**Customer**	:	Simpson & Company Ltd
2	**Application**	:	Tractor
3	**Models: -**		
4	**Engine details**		
4.1	Engine model	:	SJ 327 US Tier II
4.2	Features	:	3-cylinder, 4-stroke, water cooled, DI & NA engine
4.3	Power	:	50 HP at 2250 min
4.4	Bore x Stroke	:	95x 127 mm
4.5	Total Swept volume	:	2.7 litres
4.6	Compression ratio	:	18.3 : 1
4.7	Injection timing	:	0.8 mm lift at TDC
4.8	High pressure pipe	:	6 x 1.5 x 530 mm (OD x ID x Length)
5	**Details of fuel injection equipment**		
5.1	Pump assembly	:	0 460 423 023 -VE3/12F1125L1041
5.1.1	Connecting parts	:	Nil
5.2	**Injector**	:	F 002 C8Z 858
5.2.1	Nozzle holder	:	F 002 C80 010 - KDAL 98 P 43
5.2.2	Nozzle	:	F 002 C40 540 - DSLA 145 P 1150
5.2.3	Sealing washer	:	9 431 030 172
5.2.4	Opening pressure	:	250 - 258 bar
	(using new NH/NH spring and for resetting) Allowable drop in opening pressure drop :**up to 212 bar** (Should not be declared as defective when referred under warranty)		
5.3	**Feed pump (external)**	:	F 002 A50 021 - FP/KEG22AD111/2
5.4	**Filter**	:	F 002 H20 116
5.5	**Glow equipment**	:	Nil
5.6	**Hand primer**	:	9 440 037 000 - FP/AH 3/9
6	**Features**		
6.1	VE pump 0 460 423 023 has the following features:		
	Pump housing	:	1 465 134 758
	Drive shaft	:	1 466 100 401
	Cam plate	:	1 466 111 648
	Timing-device piston	:	1 463 104 492
	Hydraulic head	:	1 468 373 012
	Housing cover assembly	:	1 465 534 437
	Fulcrum lever	:	1 461 907 400
	Sliding sleeve	:	1 460 422 448

Control unit : 1 467 230 442
Shim : 1 460 101 620
Fitting cover : 1 465 530 861
Control lever : 1 461 933 452
or : 1 461 933 454
Stop lever : 1 461 331 359
Spring : 1 464 651 434
Solenoid : 0 330 001 042

6.2 Injector F 002 C8Z 858 consists of Nozzle holder F 002 C80 010 - KDAL 98 P 43 is a running type. Nozzle F 002 C40 540 - DSLA 145 P 1150 has the following features:

Number of spray holes : 6
Spray hole diameter : 0.188 mm
Needle lift : 0.25 mm
Characteristic group : 2
Identification : Last four digits "1150" has been inscribed on the nozzle shaft.

6.3 Filter : F 002 H20 116 (spin on type) is a running type.

Please refer to the Technical information SSE-I-45/020 for further information on spin-on type filters.

6.4 Feed pump : F 002 A50 021 - FP/KEG22AD111/2 is a running type

6.5 Hand primer : 9 440 037 000 - FP/AH 3/9 is a running type

7 Other information

7.1 Test specification chart : STS-TS-PER 2.7 a1

7.2 **Make sure that the intermediate plate is assembled to the locking screw and the drive shaft rotates freely before calibration of the pump. After overhauling/testing the pump, please set the injection timing as per the procedure and lock the drive shaft in that position by using the locking screw and ensure the intermediate plate is tied with a wire to the pump and given to the customer. Please advise the customer to remove the locking screw and use the intermediate plate after setting the injection timing on the engine.**

7.3 **Since the ball profile of DSLA Nozzle is not hardened, extreme care to be exercised in handling the Injectors and Nozzles at all levels. Do not use emery sheet or any hard material to clean the ball profile of DSLA nozzles**

7.4 Spare parts catalogue **:** Shall be mailed separately

8 Exclusive parts

Pump assembly : 0 460 423 023
Injector : F 002 C8Z 858
Nozzle : F 002 C40 540
Pump housing : 1 465 134 758
Cam plate : 1 466 111 648
Hydraulic head : 1 468 373 012

	Fulcrum lever	:	1 461 907 400
	Sliding sleeve	:	1 460 422 448
	Control unit	:	1 467 230 442
	Fitting cover	:	1 465 530 861
	Control lever	:	1 461 933 452
	Control lever	:	1 461 933 454
	Stop lever	:	1 461 331 359
	Spring	:	1 464 651 434
9	**Engine code**	:	65150 (for warranty purposes)
10	**Introduction**	:	April 2004

Applicable only for BOSCH and MICO Test benches

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Section L

LUBRICATING SYSTEM

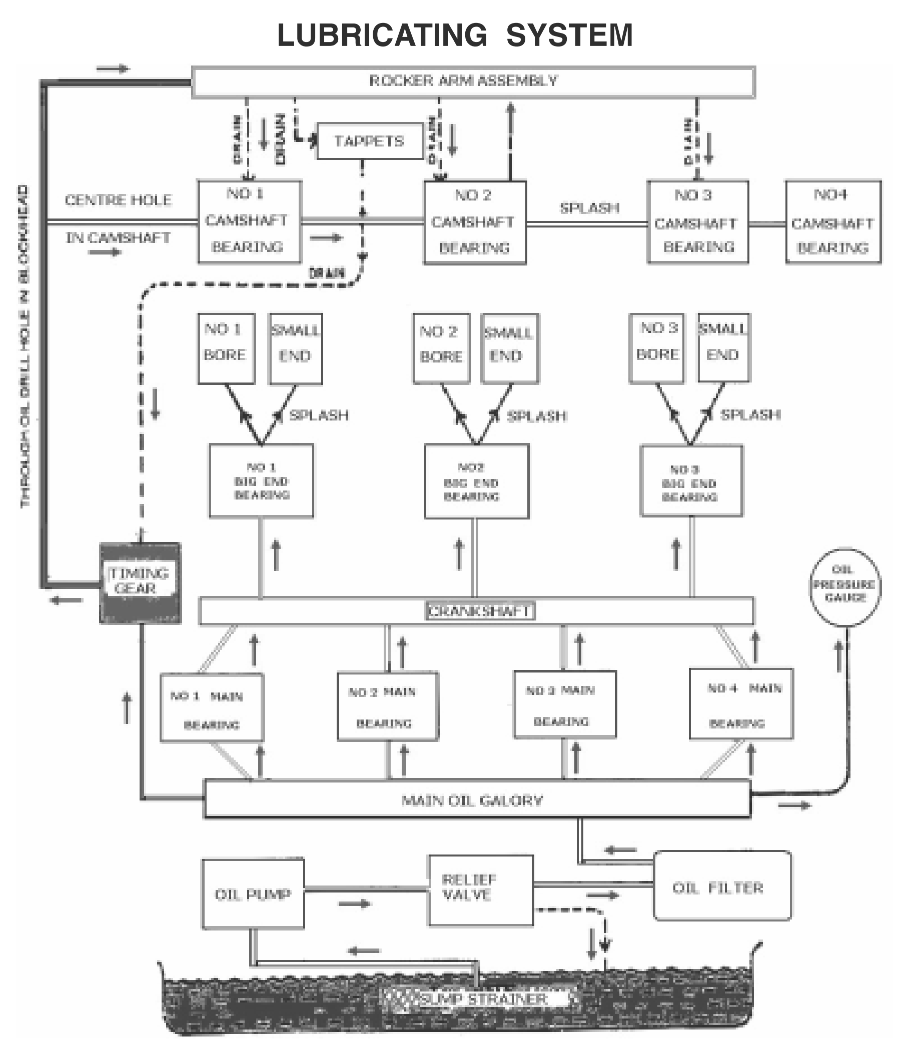

LUBRICATING SYSTEM
ROCKER ARM ASSEMBLY
DRAIN
DRAIN
TAPPETS
DRAIN
DRAIN
DRAIN
THROUGH OIL DRILL HOLE IN BLOCKHEAD
CENTRE HOLE
IN CAMSHAFT
NO 1 CAMSHAFT BEARING
NO 2 CAMSHAFT BEARING
SPLASH
NO 3 CAMSHAFT BEARING
NO4 CAMSHAFT BEARING
NO 1 BORE
SMALL END
NO 2 BORE
SMALL END
NO 3 BORE
SMALL END
SPLASH
SPLASH
SPLASH
NO 1 BIG END BEARING
NO2 BIG END BEARING
NO 3 BIG END BEARING
TIMING GEAR
CRANKSHAFT
OIL PRESSURE GAUGE
NO 1 MAIN BEARING
NO 2 MAIN BEARING
NO 3 MAIN BEARING
NO 4 MAIN BEARING
MAIN OIL GALORY
OIL PUMP
RELIEF VALVE
OIL FILTER
SUMP STRAINER

Fig. L1 – Lubrication System

The importance of correct and clean lubrication cannot be stressed too highly and all references to engine oil should be taken to mean lubricating oil which falls within the specifications given in Section Q. Care should be taken that the oil chosen is that specified for the climatic conditions under which the engine is operated.

The sump should be filled with a suitable lubricant to the correct level but do not attempt to overfill above the full mark. Before filling or checking the dipstick, ensure the application is on level ground.

Oil Circulation

The system of lubrication (Fig. L.1) comprises pressure feed to main and big end bearings, camshaft bearings, rocker shaft and timing gear train.

The pump draws oil through the strainer from the sump and delivers it by a pipe inside the crankcase through a drilling in the side of the cylinder block to the lubricating oil filter.

Oil passes through the filter and then through an internal drilling in the cylinder block to the pressure rail which is an internal passage within the crankcase.

Holes drilled in the crankcase webs feed oil from the pressure rail to the main bearings and holes in the crankshaft webs carry oil to the big end bearings. Surplus oil returns to the sump.

An oil seal prevents oil leaking along the crankshaft at the rear end and oil thrown from this seal returns to the sump.

The small end bushes are lubricated by splash and lubricating oil mist.

Running across the front of the cylinder block is an internal passage which connects with the pressure rail. The oil comes out from this passage to camshaft 1st journal and flows through the central hole running to full length of hollow camshaft. Cross drilling from this central hole delivers oil to 2nd, 3rd and 4th camshaft journals.

Oil under pressure is feed to rocker shaft through a vertical and a cross drilled passages from oil gallery.

The overflow of oil from the rocker shaft flows from the cylinder head into the camshaft tunnel and from the front of the tunnel on to the timing gears and then returns to the sump.

Lubrication of the timing gear idler hubs is by a force feed.

Lower Hub

A drilling from the front face of the cylinder block into the main bearing oil gallery, is aligned with a drilling which passes through the axle of the hub, connecting with a transverse hole in the hub, through which oil is fed to the bearing surfaces of the hub gear.

Secured to the gear retaining plate is a pipe, the other end of which is located in a blind hole in the timing case to prevent the pipe from turning. A small hole in the pipe allows oil to spray onto the teeth of the lower idler gear (The same pipe is extended for timing assembly lubrication).

Upper Hub

A transverse drilling across the front of the cylinder block from the main oil gallery feeds oil under pressure always to No. 1 journal of the hollow camshaft. This oil feed is taken from the vertical drilled passage to the rear face of the upper hub lubrication through another transverse drilling

Oil Pressure

See that oil pressure is registered on the gauge.

The actual pressure may vary with individual engines but the oil pressure at maximum engine speed and normal working temperature should be 29.86 / 59.73 psi (2.1 – 4.2 kgf/cm^2).

There will be a pressure drop while idling and a slight decrease in normal working pressure when the engine is hot.

If the oil pressure as registered on the gauge is below normal, check the following in the order given below:

1. Dipstick. Ensure the sump oil level is up to the “full” mark.
2. Oil pressure gauge. Check for accuracy with master gauge.
3. Lubricating oil filter. May be plugged.Renew element.
4. Sump strainer may be plugged. Remove, clean and replace.
5. Lubricating oil pump. Ensure that suction and delivery pipes are tight.
6. Oil pressure relief valve. Foreign matter may be preventing valve from closing.

Lubricating Oil Filters

The importance of using clean lubricating oil in the first place, and providing means to ensure that it is always clean in use, is hardly second to the importance of cleanliness in respect of the fuel.

It is imperative, therefore, that lubricating oil filters are not neglected.

To ensure cleanliness, filters are incorporated.

1. Oil Filler strainer.
2. Sump Strainer.
3. Main (full flow) filter.

The purpose of the oil filler strainer is to prevent large objects entering the sump when the engine is being filled with lubricating oil.

The sump strainer consists of a perforated container which is an integral part of the suction pipe of the oil pump.

This strainer requires no special attention, but it should be cleaned anytime the sump is removed.

Main (Full Flow) Filter

This filter incorporates a screw on canister where the element is integral with the canister. This element should be replaced not cleaned, at the appropriate time, as given in Section C.

Oil filter assembly located either in right or left side of the engine which depends upon application.

To Renew the Canister

1. Unscrew and discard old oil canister.
2. Clean the filter head and the threaded adaptor.
3. Using clean engine lubricating oil, liberally oil the top seal of the replacement canister.

4. Fill the new canister with clean lubricating oil, allowing time for the oil to filter, through the element. Screw the replacement canister on to the filter head until the seal just touches the head and then tighten by hand. Where a tool is available, tighten to 20 Nm (2.07 Kgf.m).
5. Run the engine and check for leaks. Check the oil level after running and top up as necessary.

Oil Pressure Relief Valve

The oil relief valve which is located in the oil pump body prevents the pressure becoming excessive as might otherwise happen when the oil is cold.

The relief valve comprises a spring loaded plunger.

When the predetermined pressure setting is exceeded, the valve opens and some of the oil is released,to return to the sump. This continues until the oil warms up and flows at the desired pressure. The valve then closes.

When to change the Oil

The oil in the sump must be drained in accordance with preventive maintenance and replaced by clean new oil of a specification suitable for the climate (Ref. Section Q)

To Remove Sump

Remove drain plug and drain off oil.

Remove dipstick.

Where necessary, remove setscrews securing rear of sump to flywheel housing.

Remove all setscrews securing sump to crankcase and lower sump.

To Replace sump

Remove all traces of old joints and cork strips from timing case bottom cover and rear main bearing cap.

Lightly smear crankcase faces with a thin coating of jointing compound and place joints in position ensuring all holes lined up.

When placing joints in position, it is important that the mitred ends go right up into the recesses of the timing case bottom cover and rear main bearing cap.

Lightly coat cork joints with jointing compound and place in the grooves provided in the timing case bottom cover and rear main bearing cap.

Place sump in position and screw the setscrews lightly home.

Where applicable, replace setscrews securing rear of sump to flywheel housing.

Tighten setscrews securing sump to crankcase.

Replace dipstick and sump drain plug.

To Remove Oil Pump

Remove sump (see previous heading).

Remove the bridge piece (timing case bottom half) by loosening the setscrews and nuts.

Disconnect the delivery pipe from the oil pump to cylinder block (Fig. L2).

Remove circlip and move oil pump idler gear forward.

Unscrew the three setscrews securing the oil pump to the front main bearing cap and remove oil pump.

To dismantle Oil Pump

Remove suction and delivery pipes.

Remove oil pump idler gear.

Using a special screw driver, unscrew the three screws and remove the pump end plate.

The outer rotor can then be removed.

The oil relief valve is located in the body of the lubricating oil pump. It is an adjustable valve but unless special test equipment is available, no attempt should be made to dismantle it. The relief pressure is set and adjusted before the engine leaves the works.

Inspection

The clearances for new pumps are given in Section B.

1. Thoroughly clean all parts and inspect the rotors for cracks or scores.
2. Install the driven rotor in the pump body making sure the chamfered edge of the outer rotor enters the pump body first. Check the clearance between the maximum diameter of the inner rotor and the minimum diameter of the outer rotor at all points (Fig. L4).
3. Check the clearance between the outer rotor and the pump body. (Fig. L5)
4. Check the clearance between the top of the rotors and the end of the pump body with feeler gauges and straight edge. (Fig. L 6).

Note: Should an oil pump be worn to such an extent it adversely affects the working oil pressure then a replacement pump should be obtained. The component parts of the oil pump are not supplied individually therefore

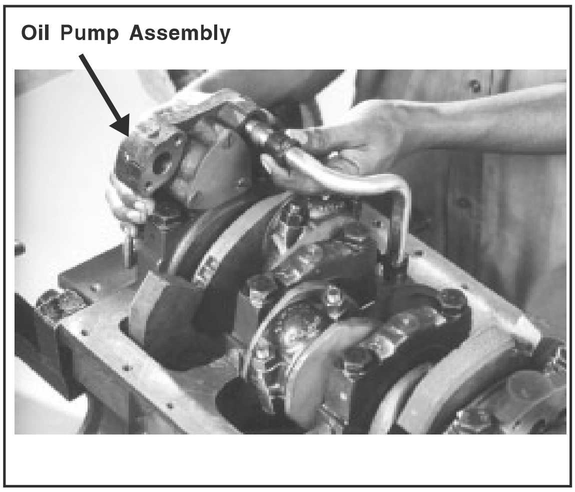


Fig. L 2 – Oil Pump / Pipe Fitting

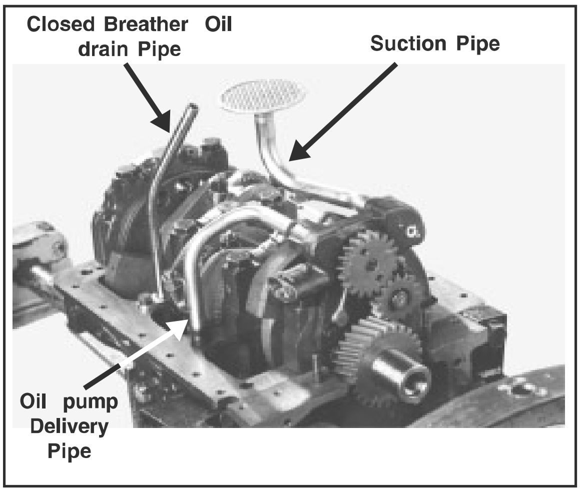


Fig. L 3 – Oil Pump / Oil Pipes

if any parts require replacing a replacement assembly should be fitted.

To Re-assemble the Oil pump

Replace outer rotor, in oil pump body. Make sure the chamfered edge of rotor towards pump body.

Replace end cover and secure with three screws.

Replace idler gear and circlip.

Prime lub oil pump with oil before fitting.

To Refit Oil Pump

Fit oil Pump to front main bearing cap and secure with three setscrews. At the same time replace suction and delivery pipes to and from oil pump.

Secure idler gear with circlip.

Replace timing case bottom half and secure with screw or nuts and washers to timing case top half.

Replace the setscrews at the bottom of the timing case front cover.

Replace sump in accordance with previous instructions.

Before starting, the engine should be turned over while operating the stop control, until oil pressure is registered.

Breathing Arrangement

The Closed Loop Breathing system ensures positive crankcase ventilation with oil separator and connecting hoses as shown in Fig. L7 / L8.

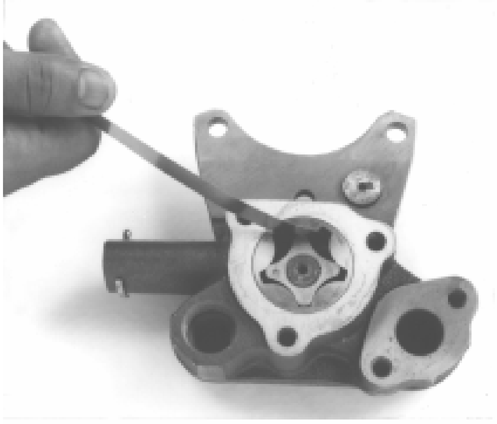


Fig. L 4 – Checking Oil Pump Clearance (Inner rotor to Outer rotor)

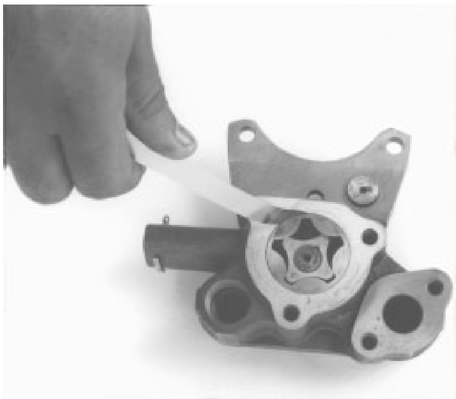


Fig. L 5 – Checking Oil Pump Clearance (Outer rotor to body)

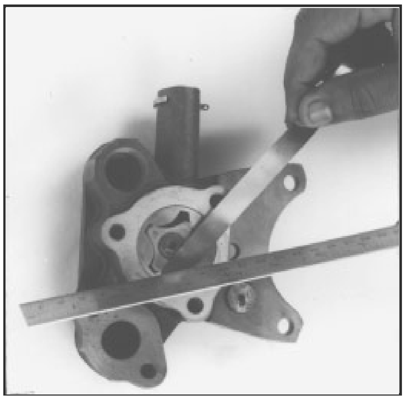


Fig. L 6 – Checking Oil pump Clearance (Top of rotors to body)

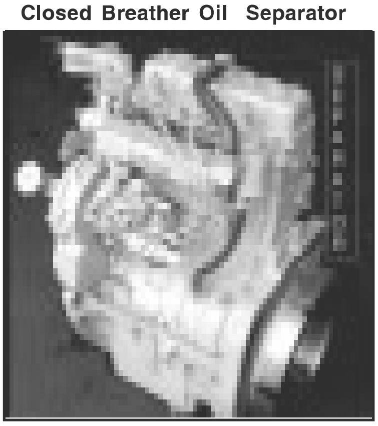

Closed Breather Oil Separator

Fig. L 7 – Oil Separator Location (Sealed Unit)

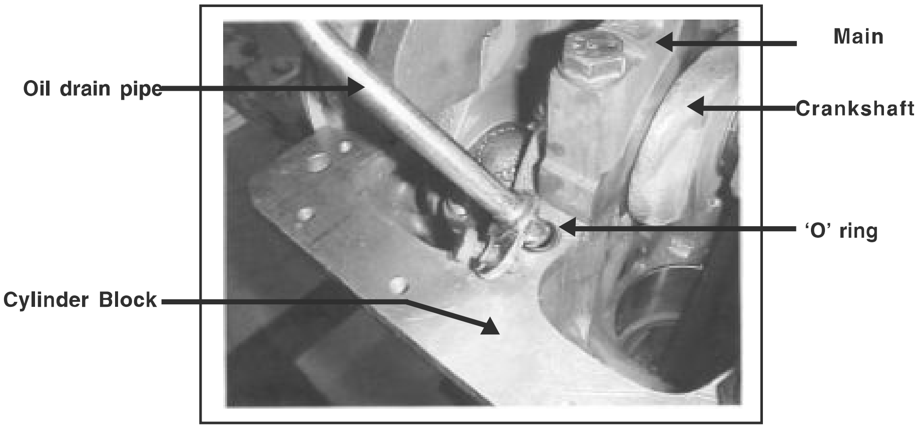

Oil drain pipe
Main
Crankshaft
'O' ring
Cylinder Block

Fig. L 8 – Closed Breather Oil Drain Pipe

CAUTION

- For effective functioning of closed loop breathing system the oil filler cap and oil dipstick should not be disturbed while engine is running.
- Perfect sealing is required between oil drain pipe 'O' ring and cylinder block machined surface as shown in Fig. L 8.

Section M

COOLING SYSTEMS

COOLING SYSTEMS

The cooling water is circulated by a centrifugal type pump which is mounted on the front of the timing case cover. It is driven by a V-belt from the engine crankshaft and provision is made for fitting a fan on the front end of the water pump pulley.

The pump does not require greasing as the bearings are treated with a special quality grease before assembly.

Fan Belt Adjustment

Belt tension should be adjusted so that, without undue pressure, the belt can be depressed approximately 3/8 inch (10 mm) with the thumb applying pressure at a point midway between the water pump and alternator pulley. (Ref. Fig. M5)

Adjustment of the belt tension is achieved by altering the position of the alternator. Release the alternator adjusting link and support bracket bolts. Move the alternator to give the correct tension and then tighten the bolts and re-check the tension.

When a new belt has been fitted it is advisable to check the belt tension after a few hours running to ensure that no initial stretching has occurred.

To Remove Water Pump

Remove Fan.

Loosen alternator securing setscrews and remove fan belt.

Remove water pump inlet and outlet hose connections.

Unscrew setscrews securing the water pump and remove.

To Dismantle Water Pump

Remove the water pump pulley using a suitable tool. The tapped holes in the pulley can be utilised for this purpose (Ref. Fig. M2).

Press the water pump shaft complete with bearings and impeller from the rear of the pump body. Press the shaft and bearing assembly out of the impeller.

Remove the unitised seal from the shaft.

The shaft and bearings are manufactured as one component and cannot be dismantled.

To Re-assemble Water Pump

With the shorter end foremost, press the shaft and bearing assembly into the rear of the water pump body until the bearing housing end is flush with the front of the water pump body.

Fit the unitised seal.

Supporting the shaft at the front end, press the impeller with blades inwards onto the rear of the shaft until a dimension of 0.0098 / 0.02 inch (0.25 mm to 0.51 mm) is obtained between the blades of the impeller and the pump body (Ref Fig. M3/M4).

Spin the assembly to ensure freedom of rotation. Replace the four setscrews (used instead of studs and nuts used for securing the water pump on to the timing case cover.

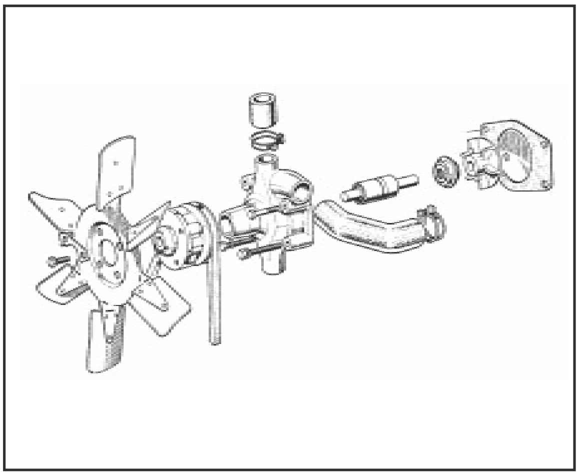


Fig. M 1 – Water Pump Exploded View

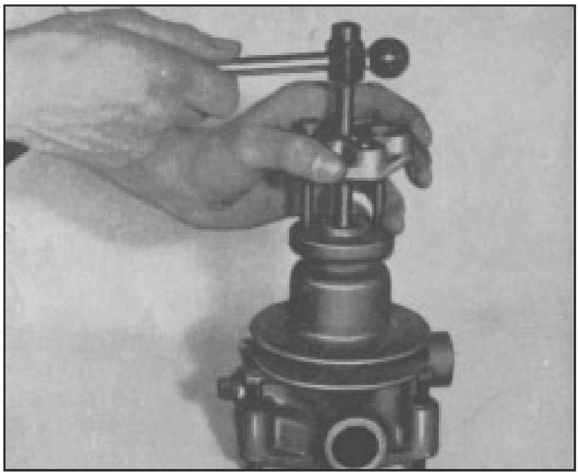


Fig. M 2 – Water Pump Pulley Removal

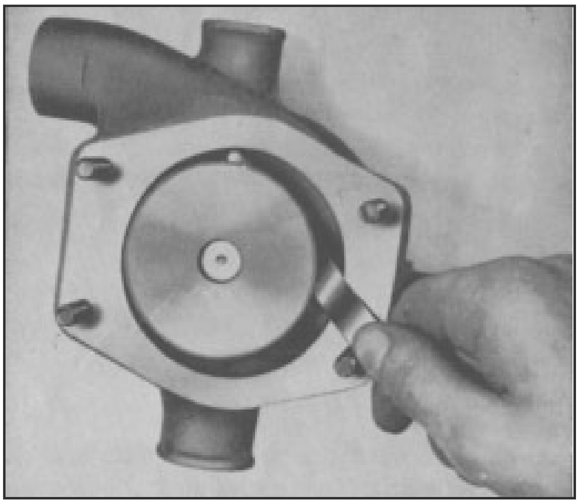


Fig. M 3 – Checking Impeller Clearance

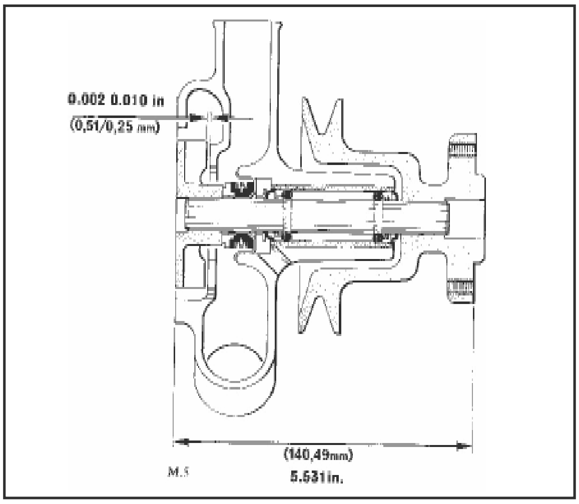


Fig. M 4 – Water Pump Cut Section

Supporting the shaft at the impeller end, press on the water pump pulley until the front end of the fan mounting face is 5.5311 inch (140.49 mm) from the rear face of the pump body (Ref. Fig. M4).

Recheck the clearance between the impeller blades and pump body, and spin the assembly to ensure freedom of movement.

To Re-fit Water Pump to Engine

Fit new water pump joint, using jointing compound.

Connect up water pump inlet and outlet hose connections.

Replace fan belt and tension.

Replace fan.

Thermostat

A thermostat is fitted in the cylinder head water outlet to assist in providing a shorter warming up period for the engine. The thermostat can be removed after the water outlet connection and joint have been removed. When refitting the thermostat, ensure that the jiggle pin (if provided) in the top of the thermostat is free to move in its location.

To check the thermostat, suspend it in water and heat gradually. With a thermometer, check that the thermostat operates at the temperatures given in Section B. If it is faulty, it should be replaced no attempt should be made to adjust a faulty thermostat.

Note : *Blanking sleeve should be provided to close the by-pass if the thermostat is not fitted.*

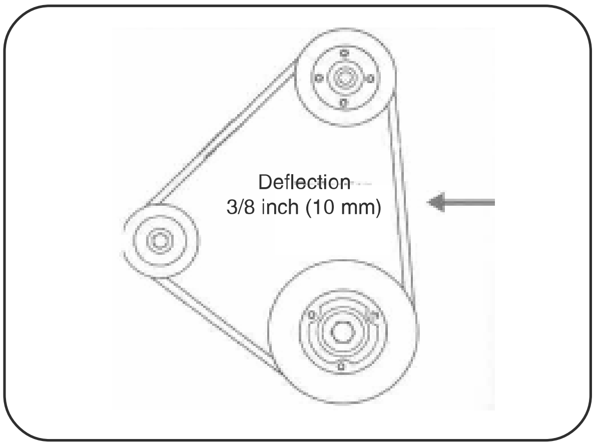


Fig. M 5 Checking Belt Tension

Section N

FUEL SYSTEM AND AIR CLEANERS

FUEL SYSTEM AND AIR CLEANER

The principal components of the equipment for delivering the fuel oil to the engine are as follows:

Filters

Fuel Lift Pump

Fuel Injection Pump

Atomisers

So accurate is the manufacture of the fuel injection equipment that the importance of cleanliness when handling fuel cannot be over stressed.

Adequate filters are provided in the system, but much can be done by the operator to ensure that the equipment is maintained in first class condition.

All fuel used must conform to :-

BRITISH STANDARD No. BS. 2869: 1970 CLASS A or I.S: 1460/2000 Grade special or Grade A and must be clean, free from water, suspended dirt and other foreign matter. Filtering of fuel before it enters the tank will help, and regular filter changing will ensure that only perfectly clean fuel reaches the fuel injection pump.

Given these conditions, ninety per cent, at least of potential engine troubles would be eliminated. Attention is on that account earnestly directed towards the section of this manual which refers to the care and upkeep of filtering apparatus.

In a pressure fed system, the lift pump lifts the fuel from the tank via the pre-filter (if fitted) and then passes it through the dual filter to the fuel injection pump, which delivers it in measured quantities and at appropriate intervals, to the atomisers.

Where no lift pump is fitted, i. e. in a gravity fed fuel system, fuel flows from the tank, through a pre-filter,to the dual filter. From there, filtered fuel enters the injection pump which delivers it to the atomisers.

The Fuel Lift Pump

The lift pump is of the plunger type and is driven by engine camshaft on the exhaust manifold side.

A hand primer is fitted for use if the supply of fuel from the tank has at any time failed, and for bleeding.

The fuel pump is an instrument of precision. Its working parts are made to extremely fine limits and mishandling in any shape or form, or the entry of the smallest particle of dirt into its working parts may damage it and diminish its accuracy of operation. Hence the importance of ensuring that the fuel is thoroughly filtered before it reaches the pump.

When requesting information regarding the fuel pump, the type and number should be quoted. This can be obtained from a plate fitted on the pump.

Fuel Pipes

No two of the pressure pipes from the fuel pump to the atomisers are alike. Keep this in mind when replacing.

Examine the nipples which will be found on each end of these pipes.

If the union nuts at any time have been over-tightened, the nipples may have been damaged. If so, leakage will result and the complete fuel pipe will have to be replaced.

In this connection, bear in mind that the working pressure which these joints must sustain is several thousand pounds per square inch. Only a perfect joint is satisfactory.

Assemble the pipe to the fuel pump and atomiser unions to check that the pipe fits square at both ends. Do not fit one end and then bend the pipe to square it with the other union.

When fitting the pipe, tighten the unions alternately a little at a time, first one end and then the other.

If the pipe is square to the unions at each end as described above, no force will be needed to make a good joint. No force should be used.

Use only a standard open ended spanner.

If the union is tightened excessively, the nipple may be damaged. The same danger exists if the pipe is not square to and central with the union.

When changing an atomiser, always remove the pipe entirely. Never undo only one end leaving the other tight. Never bend the pipe.

Atomisers

Each atomiser consists of a steel body, tightened to the cylinder head by means of a union nut. (Ref. Fig. E5 / E6,).

The joint between the atomiser and cylinder head is made by a special copper washer between the lower face of the nozzle cap nut and the recess in the cylinder head.

When preparing to fit the atomiser in its place in the cylinder head, care should be taken that only special type of copper washer is used to make this joint. The recess in the cylinder head, the faces of the copper washer and the corresponding face on the nozzle holder cap nut should be perfectly clean if a leakproof joint is to result.

It is advisable to fit a new joint washer when the atomiser is replaced, after having been removed for any reason.

Ensure that the old washer has been removed from the cylinder head or atomiser.

This joint washer should be an easy, but not loose fit for the atomiser nozzle and it is because this is such an important feature that only washers specially made for this purpose should be used and none other. On no account should ordinary spark plug type washers be used.

The atomiser can now be fitted in place, care being taken to see that it is an easy fit in the cylinder head union nuts, so that it can be placed down on the copper joint without force of any kind. The union nut should then be tightened down evenly in order to prevent the atomiser nozzle from binding and being damaged in the cylinder head. This is very important since any insufficient in tightening down may cause distortion of the atomiser nozzle resulting in its failure and will most certainly result in blowby.

Maintenance

Atomisers should be taken out for examination at regular intervals. How long this interval should be is difficult to advise, because of the different conditions underwhich engines operate.

When combustion conditions in the engine are good and the fuel tank and filtering system are maintained in first class order, it is often sufficient if the atomisers are tested at lengthy intervals. For details refer to Maintenance Section C.

It is no use taking atomisers out for attention unless an atomiser testing pump is available or spare atomisers are at hand for substitution.

Good connections along with adequate cooling and clean diesel fuel will ensure less maintenance of the atomisers and longer efficient service life. In this connection, since there is no other item upon which the performance of the engine depends so much, it pays the user to see that the engine never runs with any of its atomisers out of order.

Troubles in Service

The first symptoms of atomiser trouble usually fall under one or more of the following headings:

1. Misfiring.
2. Knocking in one (or more) cylinders.
3. Engine overheating.
4. Loss of power.
5. Smoky exhaust (black).
6. Increased fuel consumption.

Often the particular atomiser or atomisers causing trouble may be determined by releasing the pipe union nut on each atomiser in turn, with the engine running at approximately 1200 RPM. This will prevent fuel being pumped through the nozzle to the engine cylinder, thereby altering the engine revolutions. If after loosening a pipe union nut, the engine revolutions remain constant, this denotes a faulty atomiser.

After stopping the engine the nuts from the flange of the doubtful atomiser should be removed and the complete unit withdrawn from the cylinder head and test using a atomiser / nozzle tester and / or have tested by a authorised fuel pump station.

Atomiser Pressures

No attempt should be made to service or reset, the pressure of an atomiser unless the proper equipment is available. (Ref. Section B,)

When renewing atomisers, reference should be made to the appropriate Parts list to ensure fitment of the correct type.

Air Cleaners

The time period for cleaning the air cleaner depends on operating conditions. Therefore under extremely dusty conditions, the time limit recommended for cleaning or replacement period should be decreased.

The correct maintenance of the cleaner will greatly assist in extending the life of the engine.

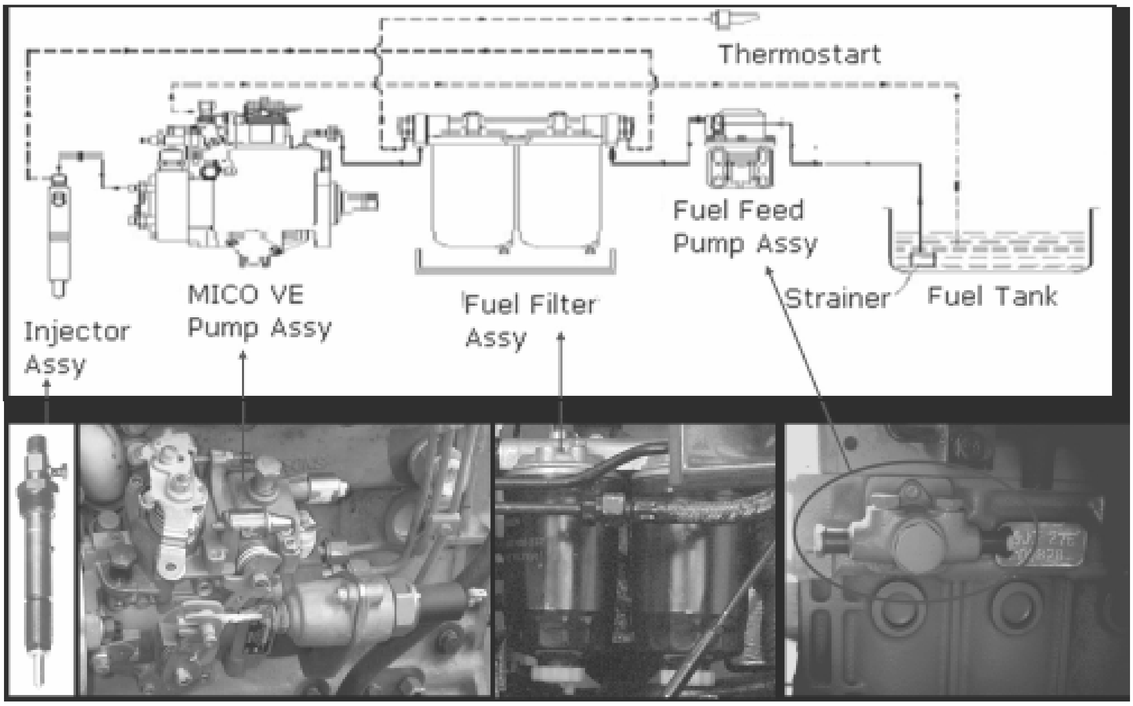
Dry type air cleaner / Maintenance

The dry type air cleaner is provided with paper elements. The elements are not to be removed or cleaned or tapped but should be replaced whenever the element is found plugged which would be identified by restriction indicator or by loss of power or speed drop or emission of black smoke from the exhaust.

A dust collecting bowl or ejector valve is provided at one end of air cleaner. The dust collected in the bowl must be emptied at the end of each day's operation initially. Depending upon the field conditions and the amount of dust collected, the frequency of emptying the above bowl can be altered. (For Details Ref. Section C,)

It should be ensured that the hose connections, metal pipe connections and their clips between the air cleaner outlet and the inlet of air inlet manifold of the engine are secured and are airtight.

Care should be taken to see that no unfiltered air enters the system through these connections. For specific type of airfilter contact concerned OEM for more details.



DO NOT CLEAN FUEL FILTERS

MICO Fuel Filter Maintenance

0.5 Litre Dual Filters

Replace first stage filter insert after every 500 hrs.

Replace second stage filter insert after every 750 hrs.

Fig. N 1 – Typical Fuel Pipe Layout

Procedure for Eliminating Air from Fuel system (SJ327E with VE type Fuel Pump)

Following procedure describes eliminating air from the fuel line system in SJ 327 E engine fitted with MICO VE type fuel injection pump applicable to tractors

1. Ensure diesel flows freely at feed pump inlet and tighten the banjo bolt.
2. Operate hand primer
   - Release air at vent screw from primary bowl of fuel filter. Ensure fuel flows without air and tighten the vent screw.
   - Release air at vent screw from secondary bowl of fuel filter. Ensure fuel flows without air and tighten the vent screw
   - Release air at over flow banjo bolt (marked OUT on banjo bolt top) of fuel injection pump. Ensure fuel flows without air and tighten the overflow banjo bolt.
3. Then loosen the three nuts of high pressure fuel pipe at atomiser.
   - Crank the engine with the help of battery until fuel flows free of air.
4. Tighten the three nuts of high pressure pipe at atomiser.
5. Engine is now ready to start.

Section P

FLYWHEEL AND FLYWHEEL HOUSING

FLYWHEEL AND FLYWHEEL HOUSING

Alignment of the Flywheel Housing and Flywheel

It is most important that the flywheel housing be correctly aligned with the crankshaft. Misalignment may give rise to difficulty in changing gear, etc. If the housing has been removed, as is necessary for a complete overhaul, the greatest care must be taken on replacement to ensure accuracy of alignment. The appropriate procedure is as follows:-

See that the face of both the rear of the cylinder block and flywheel housing are perfectly clean and free from burrs.

Set the housing on to the studs and tighten, but not overtight so as to allow adjustment.

Alignment of the Flywheel Housing Bore

Secure the base of a "dial" gauge to the flange of the crankshaft.

Set the needle of the gauge to the inside of the bored hole in the flywheel housing.

Turn the crankshaft and check that this is truly central. The housing is adjusted until it is central.

For convenience in turning the engine it is advisable to release (but not remove) the nut holding the atomisers in place.

The flywheel housing bore should be truly central with the crankshaft within the limits given in the table (total indicator reading).

Alignment of the Flywheel Housing Face

With the face of the "dial gauge" still bolted to the crankshaft flange, adjust the "dial" so as to set the needle against the vertical machined face of the flywheel housing, and, again turning the crankshaft, check that this face is perpendicular to the crankshaft axis. When carrying out this check, the crankshaft should be pressed forward to take up end float.

This facing should be within the limits given in the table (total indicator reading) of being truly at right angles to the crankshaft axis.

All adjustments to bring the flywheel housing within the limits must be on the flywheel housing and under NO CONDITIONS must the rear of the cylinder block be interfered with.

When the housing is properly aligned to the above limits, tighten the securing nuts evenly.

Ream the dowel holes and fit the correct length and size dowels.

Fitting Flywheel and Checking Alignment

With the flywheel and crankshaft flange perfectly clean and free from burrs and with two suitable guide studs fitted in the crankshaft flange, position the flywheel on the crankshaft.

Insert the setscrews complete with locking plates into the flywheel holes and tighten evenly.

Secure the base of the "dial" gauge to the flywheel housing. With the flywheel at top center, set the needle of the gauge on the periphery.

Turn the crankshaft and check the dial, the flywheel should run truly within 0.011 inch (0.30 mm) (total indicator reading).

With the base of the 'dial" gauge still bolted to the flywheel housing, adjust the dial so as to set the needle against the vertical machined face of the flywheel.

Again turn the crankshaft and check the dial. The flywheel should be truly at right angles to the crankshaft axis within the limit of 0.001 inch (0.025 mm) per 0.9842 inch (25 mm) of flywheel radius from the crankshaft axis to the dial gauge plunger (total indicator reading).

When the flywheel has been checked for correct alignment, lock setscrews with locking plates.Finally grease the spigot ball race if fitted.

LIMITS FOR FLYWHEEL /HOUSING ALIGNMENT

Housing Dia			
Upto 14.25 inch (362 mm)	....	...	0.0059 inch (0.15 mm)
Over 14.25 inch (362 mm) to 20.11 inch (511 mm)	....	...	0.0078 inch (0.20 mm)
Over 20.11 inch (511 mm) to 25.51 inch (648 mm)	....	...	0.0098 inch (0.25 mm)
Over 25.51 inch (648 mm) to 31.06 inch (789 mm)	....	...	0.011 inch (0.30 mm)

Section Q

LUBRICATING OIL SPECIFICATION

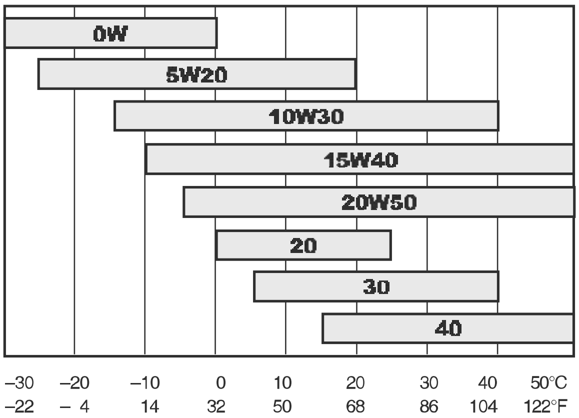
LUBRICATING OIL SPECIFICATION

Use only a good quality lubricating oil to the relevant specification as shown in the table below.

Attention : The type of lubricating oil to be used may be affected by the quality of the fuel which is available.

Always ensure that the correct viscosity grade of lubricating oil is used for the ambient temperature range in which the engine will run as shown in the chart below.

Recommended SAE viscosity grades



Ambient temperature

FUEL SPECIFICATION

To get the correct power and performance from your engine, use good quality fuel. The recommended fuel specification for Simpsons engines is indicated below :

Cetane number : 45 minimum
Sulphur : 0.2% of mass, maximum

Viscosity : 2.5/4.5 centistokes at 104°F (40°C)
Distillation : 86% at 662°F (350°C)

Density : 0,835 / 0,855 kg/litre

Cetane Number : Indicates ignition performance. A fuel with a low cetane number can cause cold start problems and affect combustion.

Viscosity : Is the resistance to flow and engine performance can be affected if it is outside the limits.

Density : A lower density reduces engine power, a higher density increases engine power and exhaust smoke.

Sulphur : A high sulphur content can cuase engine wear. Where only high sulphur fuels are available, it is necessary to use a highly alkaline lubricating oil in the engine or to renew the lubricating oil more frequently.

Distillation : This is an indication of the mixture of different hydrocarbons in the fuel. A high ratio of light-weight hydrocarbons can affect the combustion characteristics.

Low temperature fuels

Special winter fuels may be available for engine operation at temperatures below 32°F (0°C). These fuels have a lower viscosity and also limit the wax formation in the fuel at low temperatures. If was formation occurs, this could stop the fuel flow through the filter.

APPENDIX I

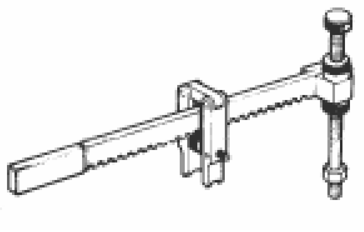
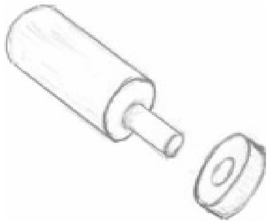
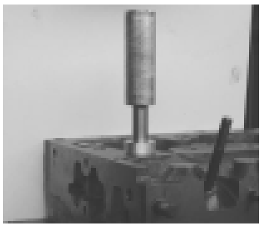
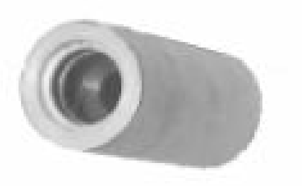
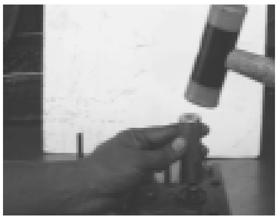
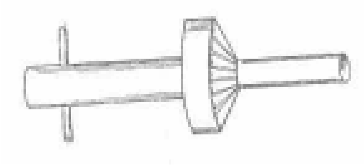
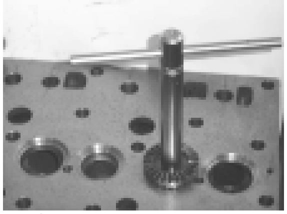
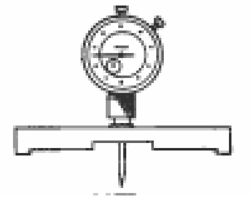
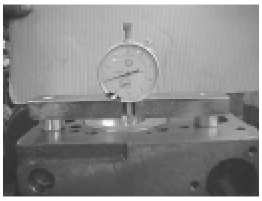
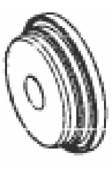
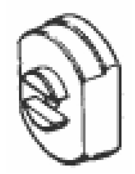
ILLUSTRATION	DESCRIPTION	TOOL NUMBER & APPLICATUION
	Cylinder head valve spring compressor with adaptor	 SER 285
	Valve guide remover and replacer (Make use of screw or arbor press)	 SER 286
	Valve stem seal replacer	 SER 287
	Valve seat cutter	 SER 294
	Piston height and valve depth gauge	 SER 349
 Replacer  Remover	Cylinder liner remover/replacer adaptors suitable for liners of 3.75 inch dia. (Make use of hydraulic press)	SER 350

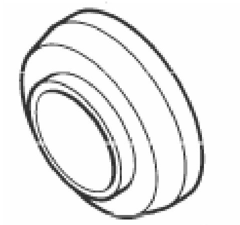
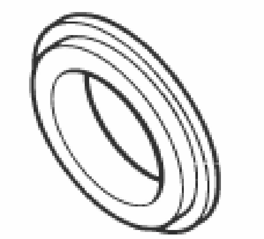
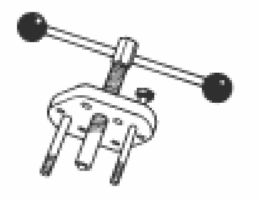
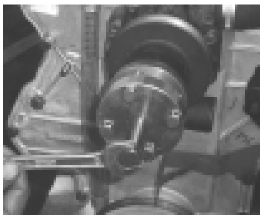
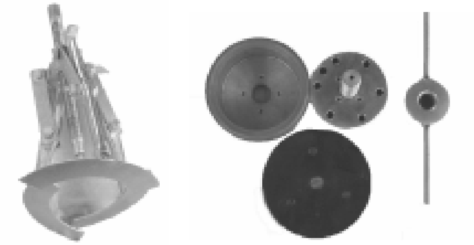
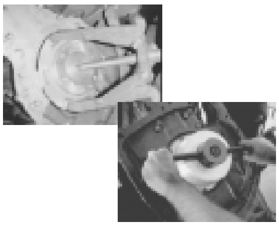
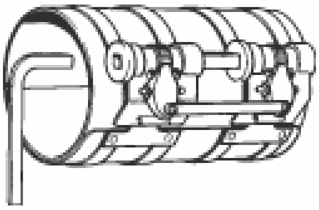
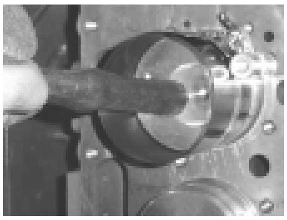
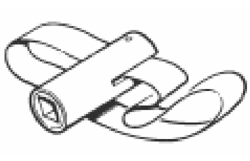
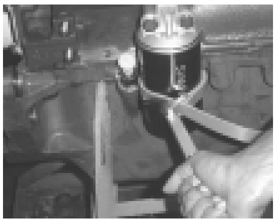
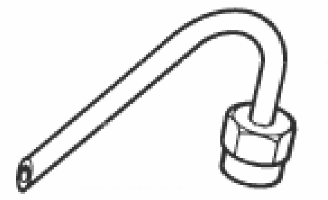
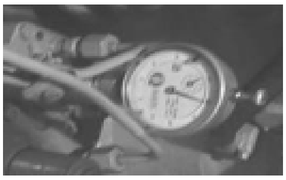
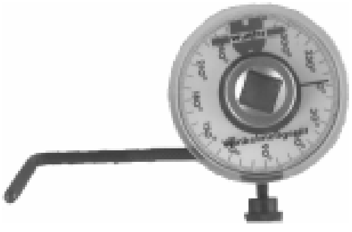
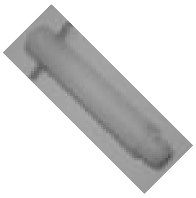
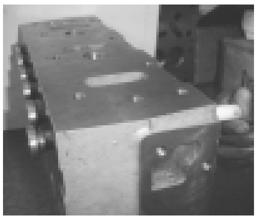
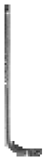
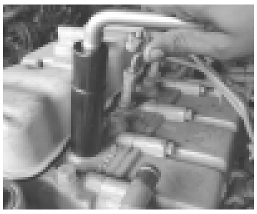
ILLUSTRATION	DESCRIPTION	TOOL NUMBER & APPLICATION
	Timing cover centraliser	 SER 290
	Timing cover oil seal replacer	 SER 291
	Basic puller	 SER 344
	Crankshaft rear end oil seal replacer (Cassette type oil seal)	 SER 342
	Piston ring compressor	 SER 348
	Oil filter remover	 SER 347

ILLUSTRATION	DESCRIPTION	TOOL NUMBER & APPLICATION
	**Used for checking pump timing :** (Applicable for In-line pump) Fuel pump spill pipe supplied with gravity tank, connecting banjo and pipe (Used for checking spill timing)	 SER 289
	Adapter to check timing using dial gauge	 SER 345
	Compressor tester	 SER 285
	Angle gauge	 SER 292
	Tappet holding stick	 SER 293
	Atomiser fuel injector remover and replacer.	 SER 346

SECTION 7

Front Axle

INDEX

7A STRAIGHT FRONT AXLE

Part A

7A STRAIGHT FRONT AXLE

Table of Contents

Operation No.	Description			Page No.
7A.1	Specification	…	…	7A - 3
7A.2	Front wheel Toe-in	…	…	7A - 5
7A.3	Front hub	…	…	7A - 5
7A.4	Front axle spindle	…	…	7A - 6
7A.5	Front axle arm assembly	…	…	7A - 7
7A.6	Center beam	…	…	7A - 8
7A.7	Front support	…	…	7A - 10

7A.1 SPECIFICATION

Type	Three piece telescopic straight front axle with adjustable tracks.

Track settings:

For 2605 2WD:

Number of setting rear wheel	6
Minimum	52.8 inch (1341 mm)
Maximum	72.8 inch (1849 mm)

For 2615 2WD:

Number of setting rear wheel	6
Minimum	53.6 inch (1361 mm)
Maximum	73.6 inch (1869 mm)

Increments (Adjustabe in steps of)	4 inch (102 mm)
Front wheel Toe-in	0.039 - 0.196 inch (1 to 5 mm)
Camber angle	3°30’
Castor angle	4°56’
Axle centre beam to support front casting clearance	0.002 inch - 0.010 inch (0.05-0.25 mm)
Arm spindle to arm assembly clearance	0 – 0.002 inch (0 – 0.05 mm)

Special Tools :

SER / 054	Tractor splitting stand
SER / 015	Front axle spindle bush remover – Main tool
SER / 016	Adapter
SER / 013	Spindle bush reamer
SER / 045	Pusher
SER / 014	Inner bearing cup replacer
SER / 012	Outer bearing cup replacer
SER / 147	Hub oil seal replacer
SER / 082	Front wheel hub remover
SER / S / 230	Pin Pivot remover

Torque value

Tie rod assembly clamp bolt and nut	37 lbf. ft. (50 Nm)
Front hub, nut hex castle	59 lbf. ft. (80 Nm)
Steering arm nut	107 lbf. ft. (145 Nm)
Tie rod bolts	37 lbf. ft. (50 Nm)
Centre beam to front axle bolts	151 lbf. ft (205 Nm)
Front support bolts	205 lbf. ft (280 Nm)

General Description

The front axle assembly consists of an axle beam and two arm assembly. The centre beam is attached to a pivot pin which pivots in the front support casting. The arm assembly can be bolted to the centre beam in alternative positions to provide front wheel track adjustments.

Fig. 1 shows the general arrangement of the front axle assy.

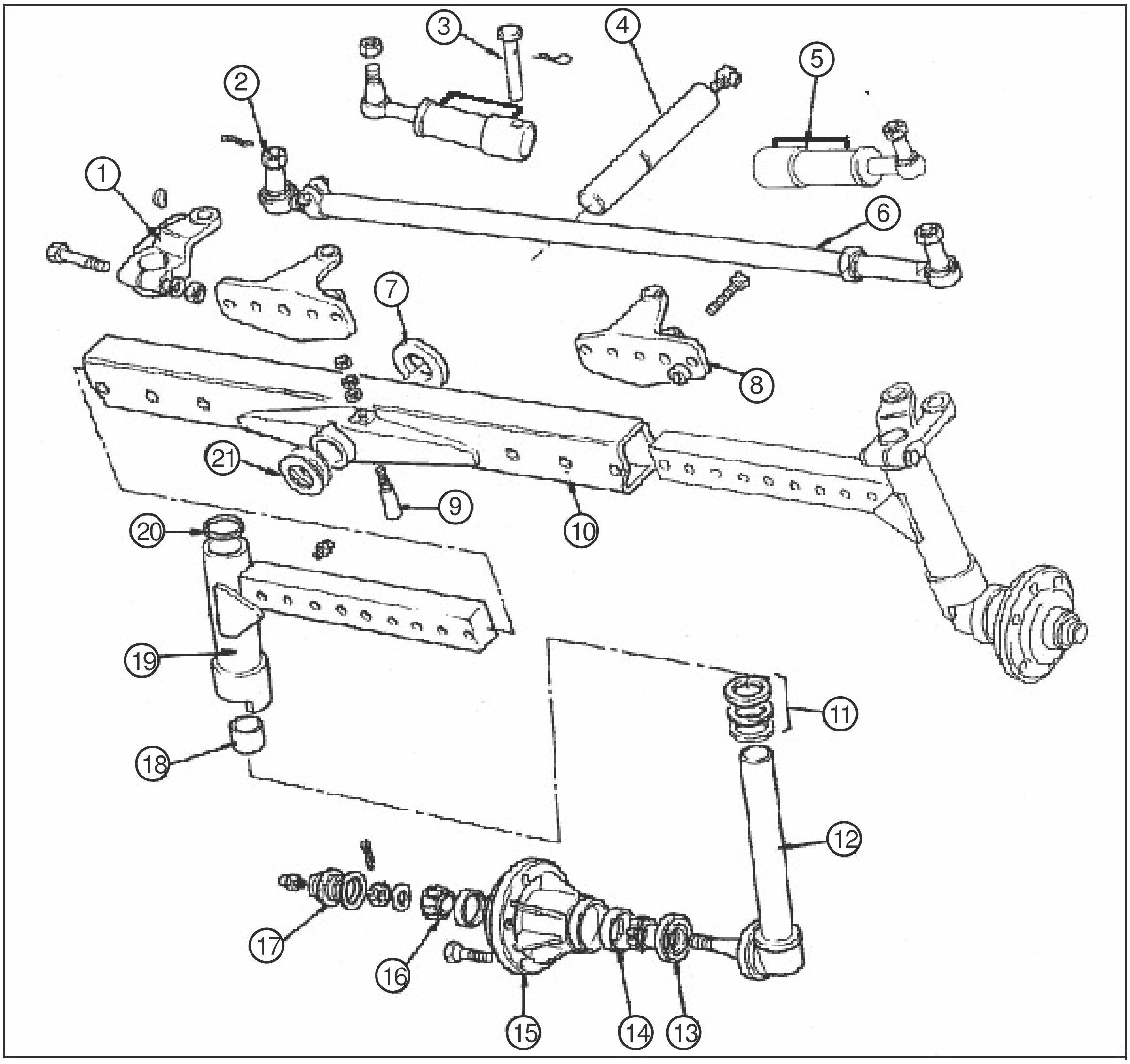


Fig 1

1. Steering arm.
2. Ball joint.
3. Steering ram pivot pin.
4. Pivot pin.
5. Steering cylinder.
6. Tie rod.
7. Thrust washer.
8. Steering ram bracket.
9. Pin.
10. Centre beam.
11. Thrust bearing and spacer
12. Spindle.
13. Seal.
14. Taper roller bearing (Inner)
15. Hub.
16. Taper roller bearing (outer).
17. Hub. cap.
18. Bush.
19. Front axle arm.
20. Seal.
21. Shims.

7A.2 FRONT WHEEL TOE-IN ADJUSTMENT

Procedure

1. The tractor must be on firm level ground with the wheels facing straight ahead position.
2. To check the toe-in, see illustrations given in Fig. 2. Distance A must be 0.039 - 0.196 inch (1– 5 mm), greater than the distance B, measured on the center line of the axle at the wheel rim.

If adjustment is required

1. Loosen the tie-rod assy. clamp bolt and nut (Item 1 in Fig.3).
2. Slacken the track adjusting set screw and nut (Item 2 in Fig.3).
3. Screw out the tie-rod tube to increase toe-in. Screw in the tie-rod tube to decrease toe-in.
4. Re-tighten the clamp nut and bolt to a torque of 37 lbf. ft. (50 Nm) and tighten the lock nut.

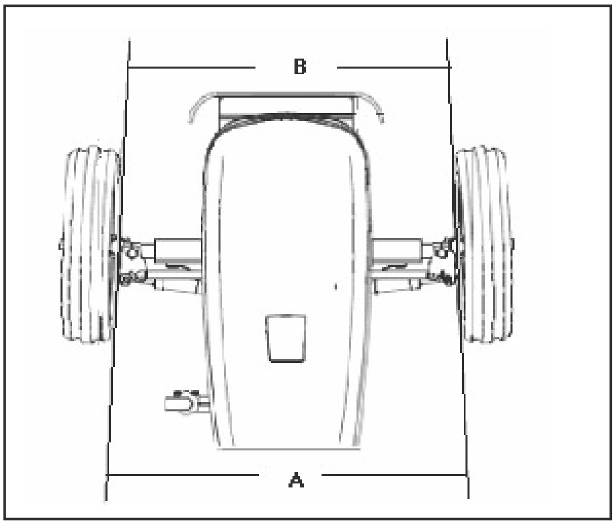


Fig. 2

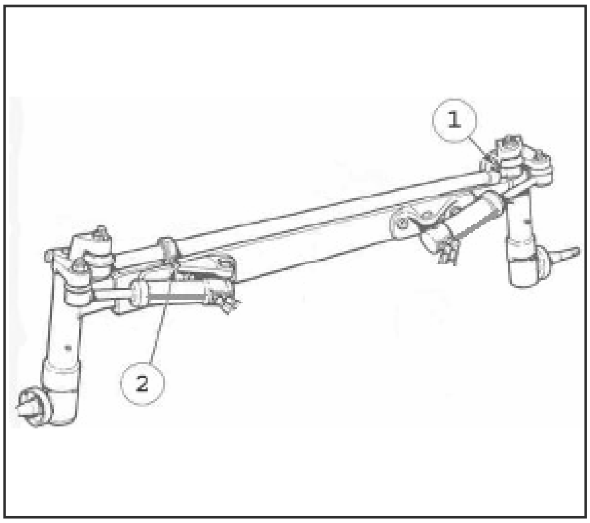


Fig. 3

7A.3 FRONT HUB OVER HAUL

Dis-assembly

1. Apply the tractor parking brake and fit wheel chocks to hold the rear wheels.
2. Raise the front of the tractor.
3. Remove the front wheel.
4. Remove the hub cap and gasket (Item 1 in Fig.4).
5. Remove and discard the cotter pin (Item 2 in Fig.4).
6. Remove the nut hex castle and washer (Item 3 in Fig.4).
7. Remove the hub assy. complete with bearing and seal from the spindle assy. (Item 4 in Fig.4).
8. Remove the outer bearing cone (Item 5 in Fig.4).
9. Tap out the outer bearing cup (Item 6 in Fig.4).
10. Remove the seal (Item 7 in Fig.4).
11. Drive out the inner bearing cone (Item 8 in Fig.4).
12. Drive out the inner bearing cup (Item 9 in Fig.4).

Examination :

Completely clean the hub components and check the condition of the hub, spindle and bearings. Any worn or damaged components should be replaced.

Re-assembly

For re-assembling, follow the reverse procedure given above, and

1. Pack the bearings with approved grease.

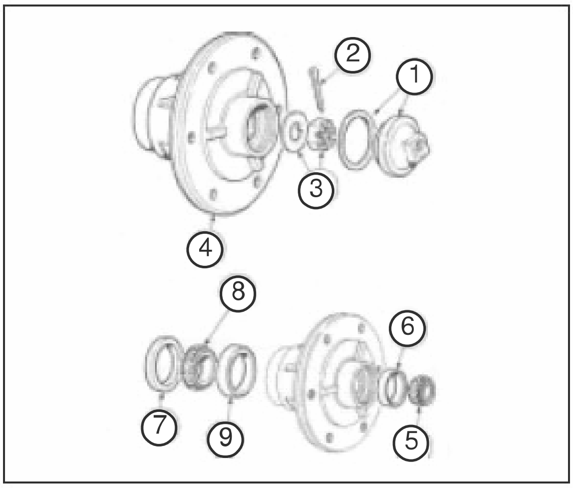


Fig 4

2. Always fit a new seal with the lip facing outward and fit the seal right into the recess of the hub.
3. Tighten the castle nut to 59 lbf. ft. (80 Nm) and then slacken off the nut to the nearest cotter pin hole to give the correct end float.
4. Re-fit the cap front wheel hub with new gasket.
5. Grease the hub through the grease nipple on the cap front hub, until grease comes out from the seal at the back of the hub.

7A.4 FRONT AXLE SPINDLE

REMOVAL AND RE-FITMENT

Removal sequence

1. Remove the hub.
2. Remove the cotter pin and nut and then detach the tie-rod assy (Item 3 in Fig. 5).
3. Detach the steering cylinder from steering arm (Item 2 in Fig. 5).
4. Remove the arm spindle bolt and nut and arm spindle (Item 3 in Fig. 5).
5. Remove the key-wood ruff (Item 4 in Fig. 5).
6. Remove the seat spindle arm dust (Item 5 in Fig. 5).
7. Lower the front axle spindle from the arm assy.
8. Remove the thrust washer and spacer from the spindle (Item 6 in Fig. 5).

Examination:

Examine the spindle thrust washer for wear or damage and replace, if necessary.

Re-fitment

For re-fitment, follow the reverse procedure above,

1. Renew the spindle arm dust seal.
2. Lubricate the thrust washer with an approved grease before re-fitting.
3. Fit the spacer to the spindle shaft followed by the thrust washer with indentations in the brass face facing downwards in contact with the spacer.
4. Refit the steering arm with bolt and nut on the inside.

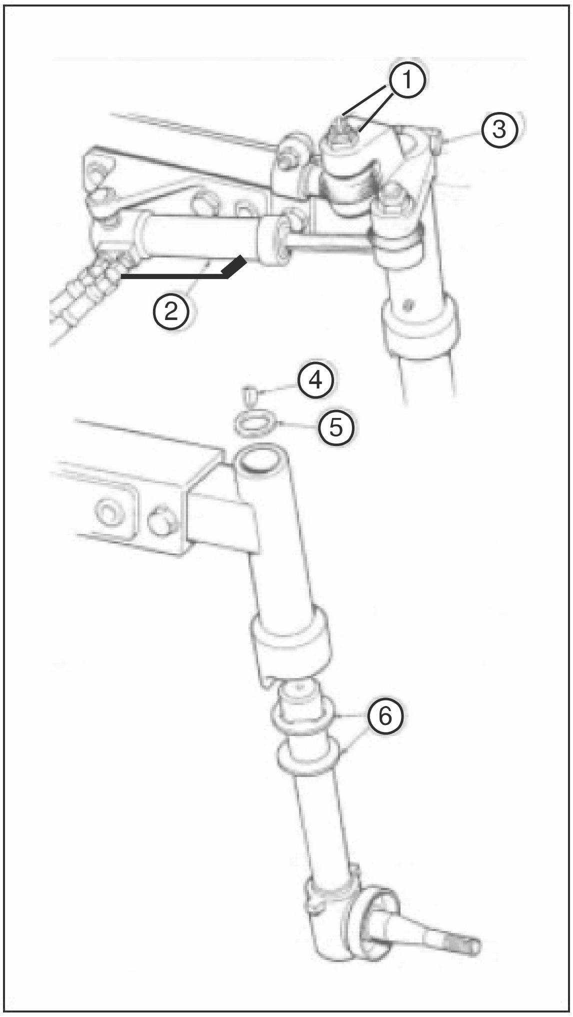


Fig 5

5. Tighten the steering arm nut to a torque of 107 lbf. ft (145 Nm)
6. Check the gap between the steering arm and arm assembly. The gap should be 0.0019 inch (0.05 mm) max.
7. Grease the spindle bearings with the wheels off the ground until the grease comes out at the top and bottom of the arm assembly.

7A.5 FRONT AXLE ARM ASSEMBLY

Removal and re-fitment

Removal sequence

1. Remove the front axle spindle with hub.
2. Remove the three nuts and bolts (Item 1 in Fig. 6).
3. Slide out the arm assembly from the centre beam. (Item 2 in Fig. 6).

Re-fitment

For re-fitment, follow the reverse procedure given above, and

1. Tighten the center beam to front axle arm assembly bolts to a torque of 151 lbf. ft. (205 Nm) with wheels on the ground.

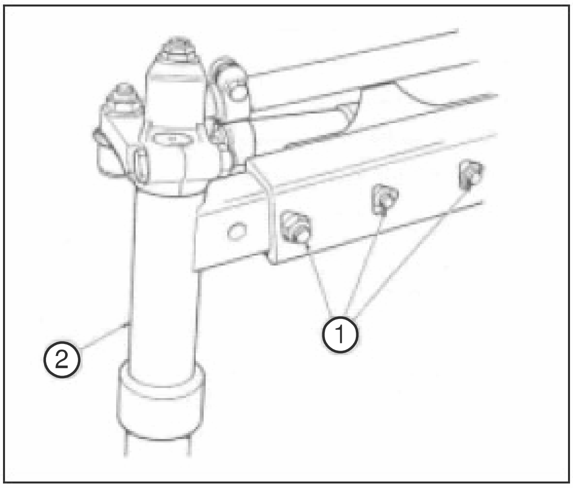


Fig 6

Overhaul

Special Tools

SER / 015 : Front Axle Spindle Bush Remover – Main tool

SER / 016 : Adapter

SER/045 : Pusher

SER / 013 : Spindle Bush Reamer

Dis-assembly

1. Remove the front axle arm assembly.
2. Secure the arm assembly in a vice (Fig. 7).
3. Use SER / 015 and SER / 016 to remove the bush by screwing the threaded extractor into the bush with the upper handle. Withdraw the bush by turning the lower handle.
4. Invert the front axle arm assembly and remove the other bush as explained above.

Re-assembly

1. Place the new bush on the front axle (Fig. 8) centrally locate the tool SER/045 on the bush and drive home the bush. Repeat the process for the bottom bush by using the tool from bottom side.

   Note: *Clean the bush seating portion thoroughly before fitment.*

2. Insert the reamer (SER / 013) through the bush as shown in the Fig. 9.

   Centrally locate the tool onto the top portion of the spindle bush and rotate it till the tool completes the travel up to the bottom portion of the top bush.

   After reaming the top bush, guide the tool further, so that the cutter gets located on the bottom bush.

   Rotate the tool in clock wise direction and take out the tool after reaming the bottom bush.

   Note : *Rotate the tool in clock wise direction only.*

   Before assembling the spindle, on the front axle, clean the metal burrs from the top and bottom bush and ensure the grease nipple holes are clear.

3. Refit the spindle shaft assembly.

   Note: *Ensure all parts are suitably greased before re-assembly.*

7A.6 CENTER BEAM

Removal and re-fitment

Special Tools

SER / 054	:	Tractor splitting stand
SER / S / 230	:	Pivot pin remover.

Removal sequence

1. Apply the tractor parking brake and fit wheel chocks to hold the rear wheels.
2. Remove the front weight frame and weights, if fitted.
3. Disconnect the headlight wire connections and remove the one piece hood or bonnect assembly.
4. Drain radiator coolant and remove the top and bottom hoses.
5. Remove the radiator assembly.
6. Remove the fan blade.
7. Raise the tractor at the front.
8. Support the tractor under the engine sump.
9. Disconnect and plug the hydrostatic steering cylinder hoses (Item 1 in Fig. 10)

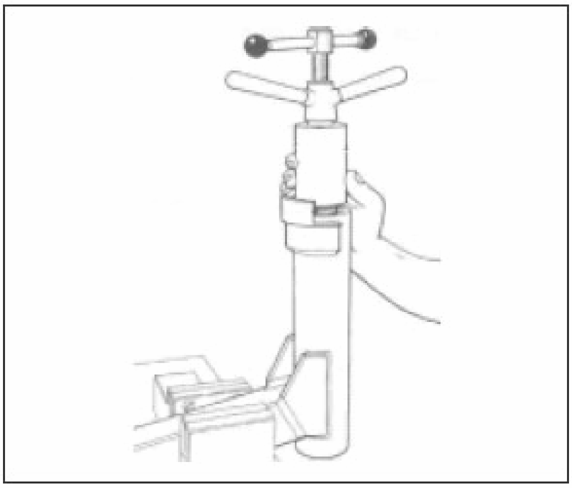


Fig 7

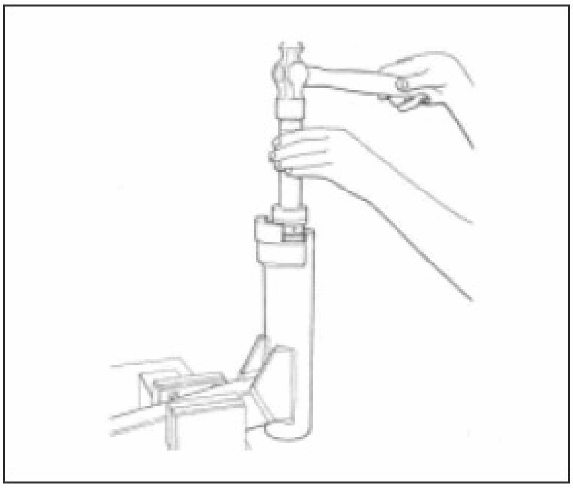


Fig 8

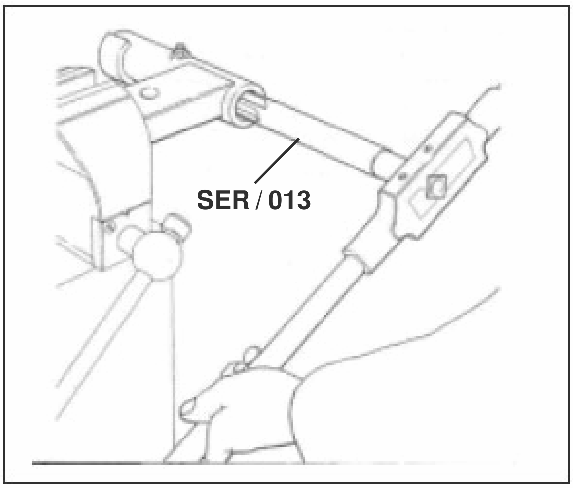


Fig 9

10. Remove steering cylinders clevis pin on both sides (Item 2 in Fig. 10)
11. Remove the tie rod assembly (Item 3 in Fig. 11)
12. Remove three nuts and bolts from each end of the center beam (Item 4 in Fig. 11)
13. Slide out both the front axle arm assemblies complete with wheel and steering cylinder. (Item 5 in Fig. 11)
14. Disconnect the remote grease hoses.
15. Push the center beam back on its pivot pin against the thrust washer. Using feeler gauges, check the gap between the front boss and the beam and the front support casting. If it exceeds 0.0098 inch (0.25 mm), note the dimension. (Fig.12)
16. Remove the pin (item 5 in fig 10) and hair pin internal (item 4 in fig 10).
17. With the centre front axle beam supported on both sides using SER / S / 230 and the 7/16” UNC adapter, remove the pivot pin from the casting.
18. Lift and remove the center beam, thrust washer and shims out from the tractor.

Examination

Check the end face of the center beam of the boss, the pivot pin and the thrust washer for wear. Examine all surfaces for wear or damages

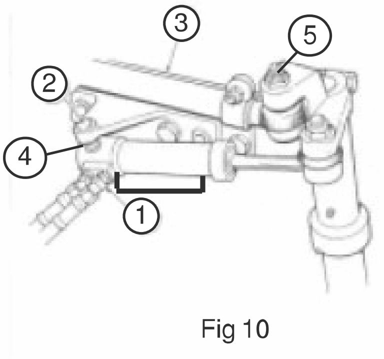


Fig 10

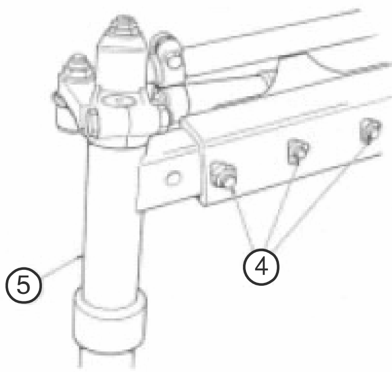


Fig. 11

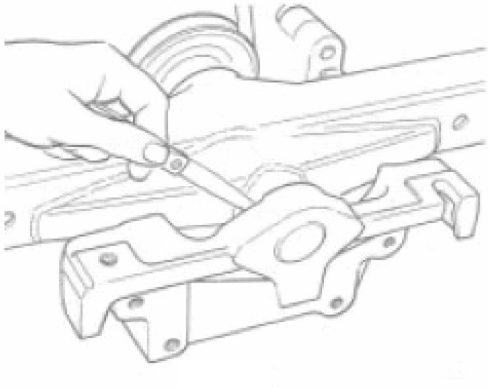


Fig 12

Re-fitment

For re-fitment, follow the reverse procedure above

1. If gap between center beam and support casting exceeds 0.0098 inch (0.25mm) suitable shims to be added in between the center beam and support casting to give a gap 0.0019 inch (0.05mm) to 0.0098 inch (0.25mm) max. Shims must be fitted to the front of the beam and thrust washer to the rear.
2. Ensure that the two hair pins are securely in place on the pivot retaining pin.
3. Re-adjust the toe-in and tighten the tie rod bolts to a torque of 37 lbf.ft. (50 Nm).
4. Tighten bolts and nuts securing front axle arm assemblies into the center beam to a torque of 150 lbf.ft. (205 Nm) with the wheels on the ground.

7A.7 FRONT SUPPORT

Removal and Refitment

Special Tools

SER / S / 230 : Pivot pin remover
SER / 054 : Tractor splitting stand.

Removal sequence

1. Remove the front end weights and frame.
2. Disconnect the headlight wire connections and remove the one piece hood or bonnet assembly.
3. Drain radiator water and remove the top and bottom hose. Also remove air cleaner hose.
4. Remove the radiator assembly.
5. Support the tractor under the engine sump.
6. Disconnect the remote grease hoses.
7. Support the center beam to prevent it from rolling over after removal of the pivot pin.
8. Using the SER / S / 230 withdraw the center beam pivot pin.
9. Lift the center beam carefully complete with arm assemblies and wheels using a crane.
10. Support the front support casting suitably to prevent if from falling down.
11. Remove all bolts and nuts securing the front support casting to the engine.
12. Lift out the front support casting.
13. Remove the spacer and shims from the right top stud in the engine.

⚠ **WARNING : The front support casting is very heavy, so care should be taken in handling it.**

Re-fitment

For re-fitment, follow the reverse procedure given above, and

1. Shims are to be fitted in between the top spacer and the front support casting on the right hand side to give 0.0051 inch (0.13mm) slack pre-load.
2. Tighten all bolts and nuts to a torque of 207 lbf. ft. (280 Nm) except the stud with the spacer.

Overhaul

Special Tools

SER / 45 : Pusher
SER / 014 : Inner bearing cup replacer
SER / 012 : Outer bearing cup replacer
SER / 147 : Hub oil seal replacer
SER / 082 : Front wheel hub remover
SER / S/ 230: Pivot pin remover

Dis-assembly

1. Remove front support casting.
2. Remove the two bushes from front support casting.

Re-assembly

For re-assembly, follow the reverse procedure given above, and

1. Use SER / 45 to re-fit the bushes and ensure the grease holes in bushes are aligning with the hole in the front casting support.
2. If gap between center beam and support casting exceeds 0.0098 inch (0.25mm) suitable shims to be added in between the center beam and support casting to give a gap 0.0019 inch (0.05mm) to 0.0098 inch (0.25mm) max. Shims must be fitted to the front of the beam and thrust washer to the rear.

***Note :** Please refer Special Tool Guide for usage procedure of the above special tools.*

SECTION 7

Part B

4WD Front Axle

SECTION 7

Part B

4WD Front Axle

Table of Contents

Operation NO	Description	Page NO
7B - 1	Specification	7B - 3
7B - 2	General description	7B - 6
7B - 3	Wheel alignment and steering stops	7B - 14
7B - 4	Track rod and ball joint	7B - 15
7B - 5	Front axle removal and refitment	7B - 16
7B - 6	Planetary carrier removal and refitment	7B - 19
7B - 7	Planetary carrier overhauling	7B - 20
7B - 8	Hub oil seal	7B - 21
7B - 9	Swivel housing and king pins	7B - 24
7B - 10	Drive shaft and oil seal	7B - 26
7B - 11	Drive shaft overhauling	7B - 29
7B - 12	Differential assemble removal and refitment	7B - 30
7B - 13	Differential assemble overhauling	7B - 31
7B - 14	Pinion oil seal	7B - 34
7B - 15	Crown wheel pinion overhauling	7B - 36
7B - 16	Steering ram removal and refitment	7B - 39
7B - 17	Steering cylinder (OGNIBENE) overhauling	7B - 41
7B - 18	Steering cylinder (Polyhydron) overhauling	7B - 51

7B - 1 SPECIFICATION - FRONT AXLE:

Axle type - MF2605/2615 tractors	...	Offset driven banjo type axle
Camber angle	...	1.5°
Toe-in	...	0 - 5 mm (0 - 0.196 inch).
Axle reduction ratio - crownwheel and pinion	...	3.182 : 1
Epicyclic reduction ratio	...	3.882 : 1
Overall reduction unit	...	12.35 : 1
Crown wheel and pinion backlash	...	0.006 - 0.010 inch (0.15 to 0.25 mm).
Deflection of left-hand bearing cap	...	0.002 - 0.004 inch (0.05 to 0.1 mm)
King pin clearance	...	0.006 inch (0.15 mm) max

Oil capacity:

Hub - each side	...	0.132 gal + 0.132 gal (0.5 lts + 0.5 lts) (Both left and right hand side).
Axle	...	1.452 gal (5.5 lts).

Bolt torques

Track rod locknuts	...	81 - 88 lbf.ft (110 - 120 Nm)
Steering cylinder ball joints	...	169 - 184 lbf.ft (230 - 250 Nm)
Ball joint nuts	...	114 - 125 lbf.ft (155 - 170 Nm)
Wheel nuts	...	199 lbf.ft (270 Nm)
Planetary carrier cap screws	...	44 - 51 lbf.ft (60 - 70 Nm).
Hub retaining nuts	...	250 - 258 lbf.ft (340 - 350 Nm).
Pinion nut	...	66 - 73 lbf.ft (90 - 100 Nm)
Differential case bolts	...	59 - 66 lbf.ft (80 - 90 Nm).
Differential bearing cap bolts	...	88 - 95 lbf.ft (120 - 130 Nm).
Steering ram cap screws	...	81 - 88 lbf.ft (110 - 120 Nm).
Bearing lock tab bolt	...	11 - 19 lbf.ft (16 - 26 Nm).
King pin mounting bolts	...	44 - 51 lbf.ft (60 - 70 Nm).
Differential carrier to axle housing	...	95 - 103 lbf.ft (130 - 140 Nm).
Axle housing filler plug	...	22 - 29 lbf.ft (30 - 40 Nm)
Planetary carrier filler plug	...	22 - 29 lbf.ft (30 - 40 Nm)
Magnetic drain plug axle housing	...	36 - 44 lbf.ft (50 - 60 Nm)
Lock nut axle stopper bolt	...	88 - 95 lbf.ft (120 - 130 Nm)

Special Tools

SER / 300	...	Pusher to press Bush in Diffcase LH/RH
SER / 302	...	Pusher to press Cone Bearing in Diffcase LH/RH
SER / 303	...	Pusher to press Crown Wheel in Diffcase
SER / 304	...	Press Cone Bearing in Pinion
SER / 305	...	Pusher to press Cup Bearing Inner in Diff carrier
SER / 306	...	Pusher to press Cup Bearing Outer in Diff carrier
SER / 307	...	Pusher to press Oil Seal in Diff Carrier
SER / 308	...	Pusher to press Needle Roller Bearing in Swivel Housing (Manual Pressing)
SER / 309	...	Pusher to press Cone Bearing in Swivel Housing
SER / 310	...	Pusher to press Oil Seal in Swivel Housing (Mating with Wheel Hub) Big
SER / 311	...	Pusher to press Cup Bearing Inner in Wheel Hub
SER / 314	...	Pusher to press Cone Bearing in Annular Gear
SER / 315	...	Tighten and Torque Lock Nut
SER / 316	...	Pusher to press shaft pinion planetary
SER / 317	...	Pusher to press Needle roller bearing in drive shaft bores of axle housing
SER / 318	...	Pusher to press Oil seal in drive shaft bores of axle housing
SER / 319	...	Pusher to press Cup Bearing in King Pin Bores
SER / 320	...	Pusher to press Oil Seal in King Pin Bores
SER / 352	...	Gland assembly tool
SER / 353	...	Rod mounting bell
SER / 354	...	Rod seal mounting bell
SER / 355	...	Piston seal pusher tool
SER / 356	...	Piston seal calibration tool
SER / 357	...	Piston seal pusher
SER / 358	...	Piston seal loader
SER / 359	...	Piston Seal resizer
MF 485 / 1	...	Pivot pin seal installer
MF 444	...	Axle pivot pin remover
SER 360	...	Drive shaft end float checking tool

Refer table for snap on tools for removal of bearing cup, cones and needle roller bearing etc...

S.NO	APPLICATION	SPX - OTC CATALOG PART NUMBER REFERENCE	PULLER DESCRIPTION	OTC Tool Page No.
1	Removal of cup from diff carrier	1178	Slide hammer puller set. Can only be used with slide hammer	210
2	Removal of cup from wheel hub	1158	Slide hammer puller. Can only be used with slide hammer	207
3	Removal of cup from swivel housing			
4	Removal of cup from annular ring	1045	17-1/2 ton 3 jaw puller, 14-1/2" max reach, 14" max spread	202
5	Removal of cone bearing in differential case right-hand			
6	Removal of cone bearing in differential case left-hand			
7	Removal of cone from bevel pinion			
8	Removal of cup from axle housing	1176	Slide hammer puller set. Can only be used with slide hammer	207, 210, 214, 216
9	Removal of needle roller bearing from swivel housing			
10	Removal of cone from bevel pinion small end	1043	17-1/2 ton 2 jaw puller, 14-1/2" max reach, 14" max spread	202

7B - 2 General description.

The axle described in this manual designed and manufactured following the client requests, consists of a beam casing housing the differential and a wheel hub unit at each end.

The differential, type “open”, is supported by two bearings mounted on a suitable structure allowing the bevel gear set to be adjusted.

The ring bevel gear is adjusted by means of ring nuts located opposite each other.

The position of the bevel pinion, supported by two bearings, is adjusted by inserting adjusting shims.

The drive torque is transmitted from differential side gears to planetary sun gears through drive shaft.

The drive shaft is supported at axle housing and swivel housing by needle roller bearings with proper seals in position.

The wheel hubs containing the epicyclic reduction gears are supported by two tapered roller bearings. The wheels ends are steered by hydrostatic power steering.

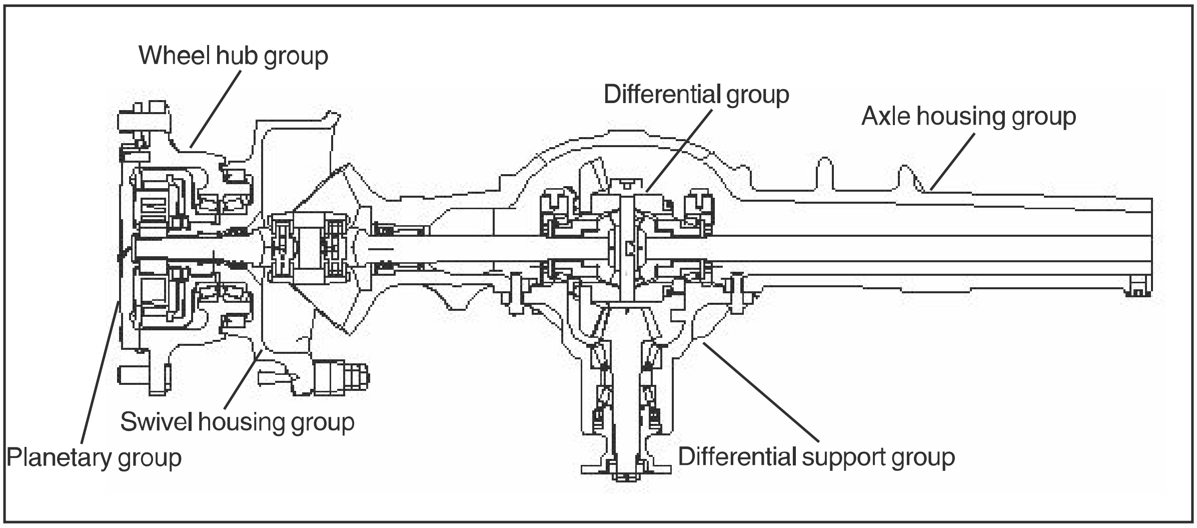

Wheel hub group
Differential group
Axle housing group
Swivel housing group
Planetary group
Differential support group

Fig 1

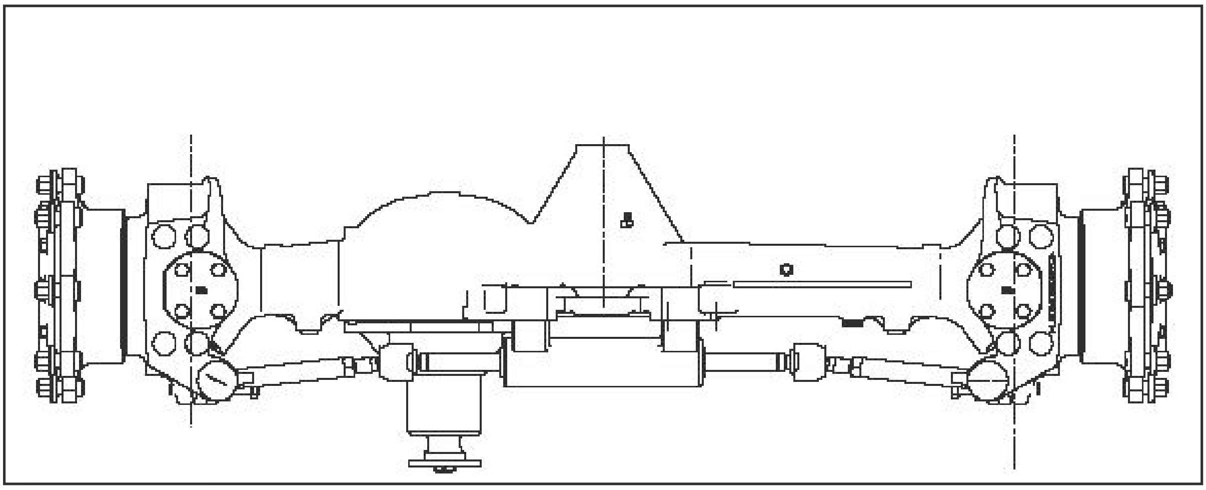


Fig 1a Front axle top view

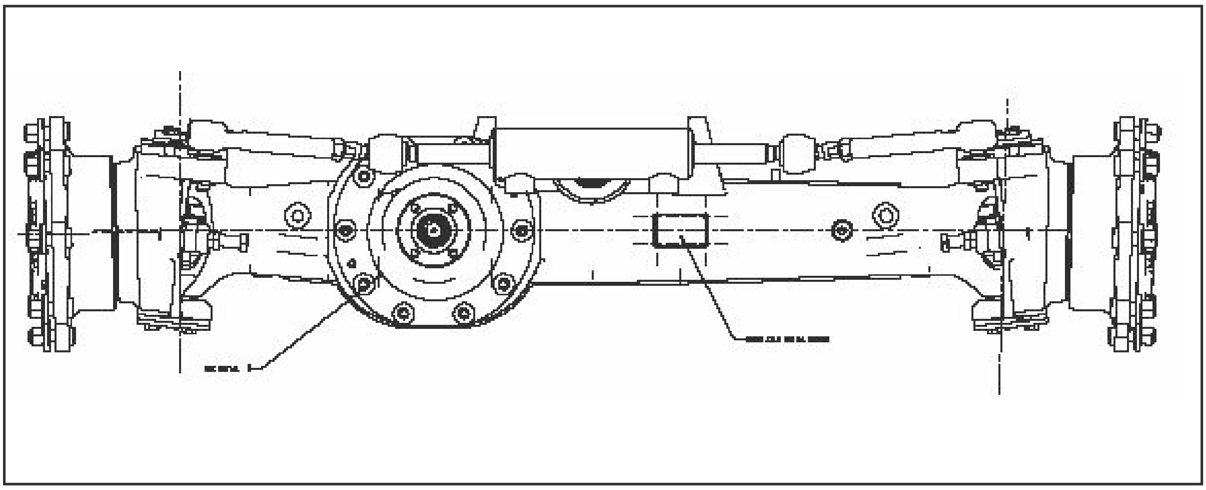


Fig 1b Front axle Front view

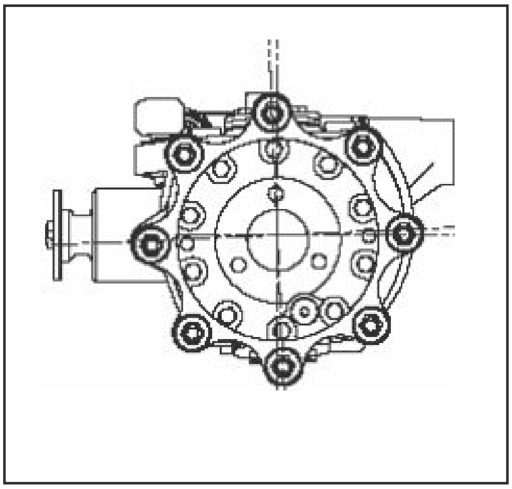


Fig 1c Front axle Side view

4WD LUBRICATION AND GREASING

PERIODICAL CHECKS :

In the 4WD front axle, lubricant should be maintained up to the level of plug (1 & 4 in Fig. 1d). If not, top up with recommended grade of oil.

Low oil level could be an indication of a leak and should be repaired in order to prevent damage to internal mechanical parts.

Loosen and remove the drain plug (2 in Fig. 1d) for oil draining.

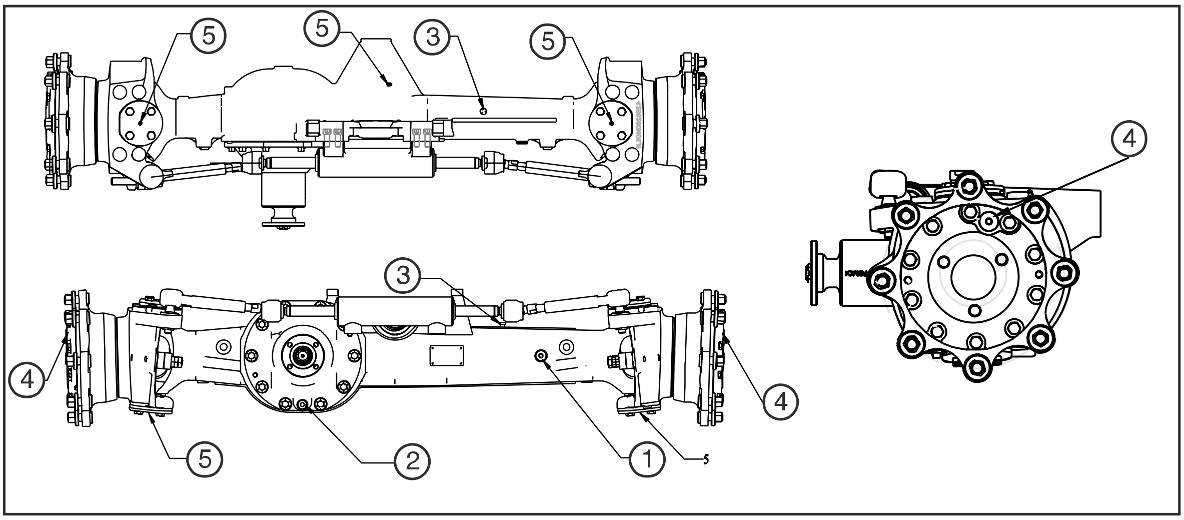


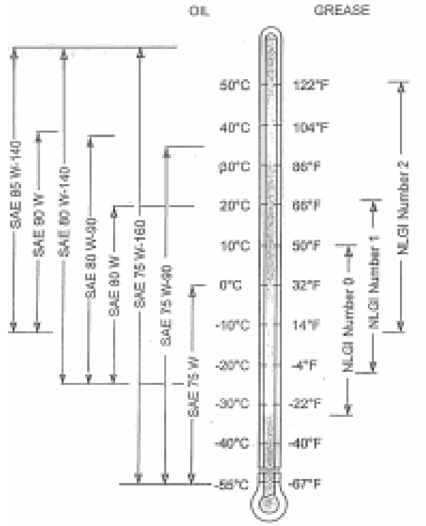
Fig. 1d

(1) Differential oil filling and level plug, (2) Differential oil drain, (3) Oil breather,
(4) Epicyclic reduction oil fill / Drain and level, (5) Greasing point.

PERIODIC LUBRICATION TABLE

OIL CHANGE	*First Time 150–200 Hrs*	*Seasonally or every 1000 Operating hrs whichever comes first*
LUBRICATION WORKS	—	Monthly
CHECK AND ADJUST OIL LEVEL	*First Time 150 – 200 Hrs*	Monthly
CLEAN MAGNETIC OIL DRAIN PLUG	First Time 150 – 200 Hrs	Every Oil Change
CLEAN OIL BREATHER	—	Monthly
GREASING	*First Time 150 – 200 Hrs*	Monthly

LUBRICATION/GREASING GRADES AND APPLICATION RANGE



Remarks :
▨ = operation to be performed by vehicle's manufacturer authorized personnel only
☐ = operation to be performed by trained personnel only

FRONT AXLE 4WD

Steps to be followed for checking the oil level in front axle differential.

Move the tractor onto level ground. Remove the filler/ level plug (Fig. 1e) on the axle housing. Using a 8 mm hexagon key remove the plug. The oil must be level with the bottom edge of the hole. If not, add oil of the correct grade.

Steps to be followed for changing oil

1. With the tractor standing on level ground, place a drain pan beneath the front axle.
2. Remove the drain plug (Fig. 1f) and the filler/level plug (Fig 1e) and allow the oil to drain, preferably while the oil is still warm.
3. Refit the drain plug, then refill the front axle with an approved oil up to the bottom edge of the filler/level plug. Refit the filler level plug.

***NOTE** : Time should be allowed for the oil to settle inside the front axle before rechecking the level.*

Steps to be followed for checking the oil level in front axle epicyclic hubs

Move the tractor onto level ground. Turn the wheel so that the plug (Fig. 1g) is at the three o' clock position.

Using a 8 mm hexagon key remove the plug. The oil must be level with the bottom edge of the hole. Add oil of the correct grade if the oil level is low.

Steps to be followed for draining the oil level in front axle epicyclic hubs

1. Put the tractor on level ground and turn the wheel until plug (Fig. 1h) is in the 6 o' clock position.
2. Remove the plug and allow the oil to drain, preferably after a period of work while the oil is still warm.
3. When the oil has fully drained, rotate the hub until the plug is in the three o' clock position.

   Refill with recommended grade of oil up to the level of plug opening and refit the filler level plug.

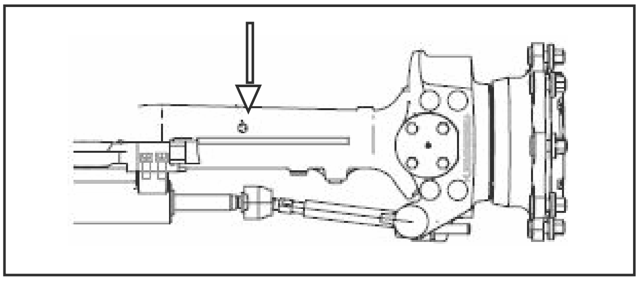


Fig 1e

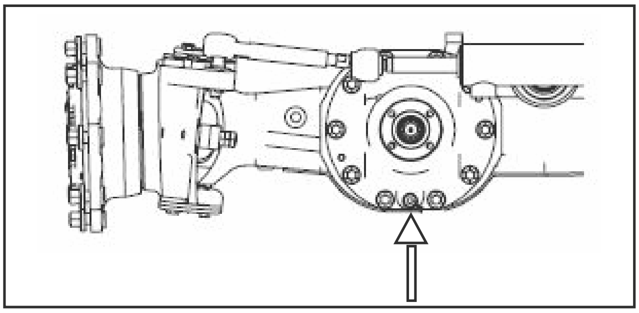


Fig 1f

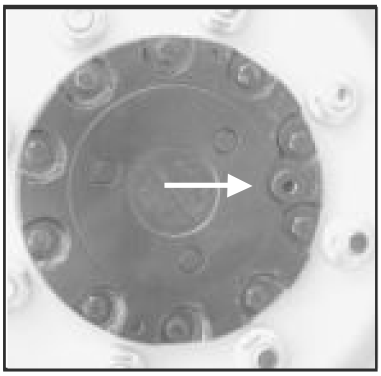


Fig. 1g

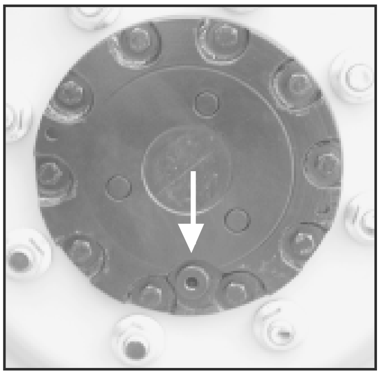


Fig. 1h

FRONT AXLE 4WD

GREASE LUBRICATION – ***Grease the fittings illustrated below with a good quality lithium based grease***

FRONT AXLE PROPELLER SHAFT(Fig.1i)

Grease the Propeller shaft every 100 hours.

Lubricate both the universal joints and the sliding joint with grease.

Loosen the clips and slide back the cover (1).

Grease the universal joint (2).

Remove the small plug (3) in the sliding coupling and replace it with a grease nipple with a 1/4 in UNF thread. Grease the coupling.

Replace the plug and guard, then repeat the operation for the universal joint at the front of the shaft.

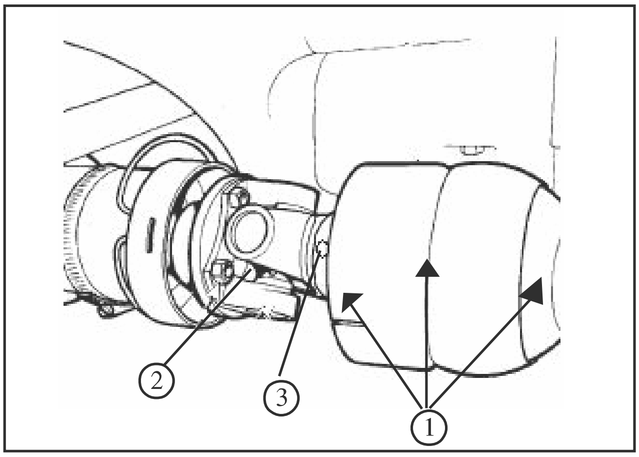


Fig.1i

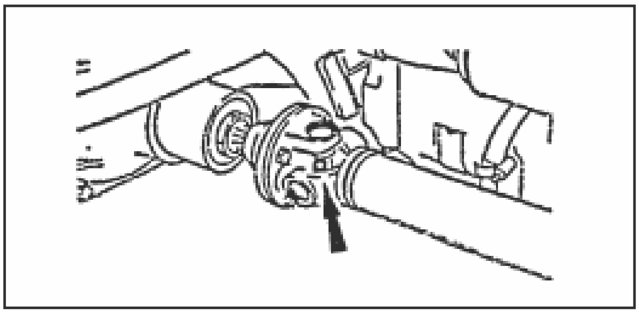


Fig. 1j

PROPELLER SHAFT FRONT (Fig. 1j)

Slide back the propeller shaft guard.

Grease every 100 hours – 1 point.

After greasing, the guard must be moved back to its original position.

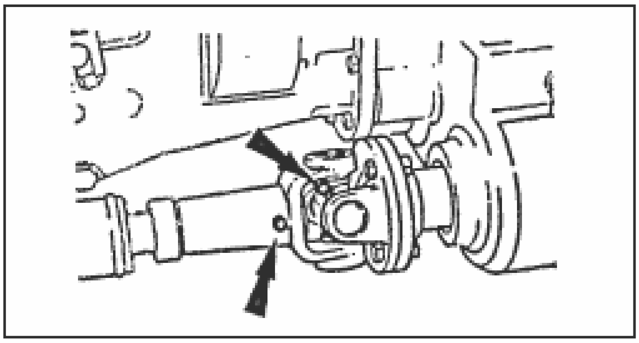


Fig.1k

PROPELLER SHAFT REAR (Fig. 1k)

Slide back the propeller shaft guard.

Grease every 100 hours – 2 points.

After greasing the guard has to be moved back to position.

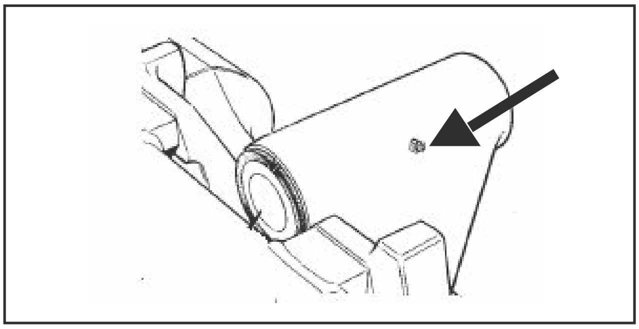


Fig. 1l

FRONT AXLE PIVOT PIN (Fig. 1l)

Grease every 100 hours – 1 point.

Grease : MF approved grease (Part no.- 3620209M2) or equivalent.

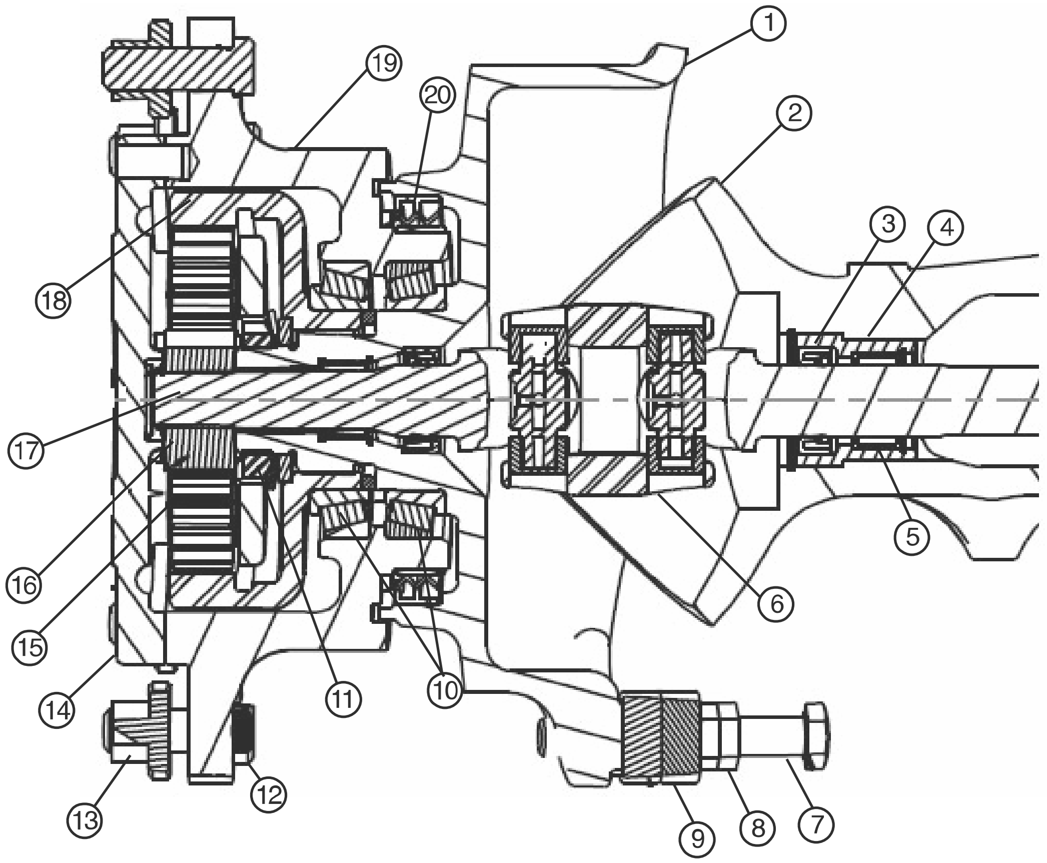


Fig 2 Four wheel drive Front axle (Wheel end cut section)

1. Swivel housing.
2. Axle housing.
3. Oil seal.
4. Sleeve.
5. Needle roller bearing.
6. Universal joint.
7. Axle stopper bolt.
8. Nut.
9. Spacer.
10. Taper roller bearing.
11. Lock nut.
12. Bolt.
13. Nut.
14. Planetary carrier.
15. Planetary gear.
16. Sun gear.
17. Drive shaft.
18. Annular ring gear.
19. Wheel hub.
20. Oil seal.

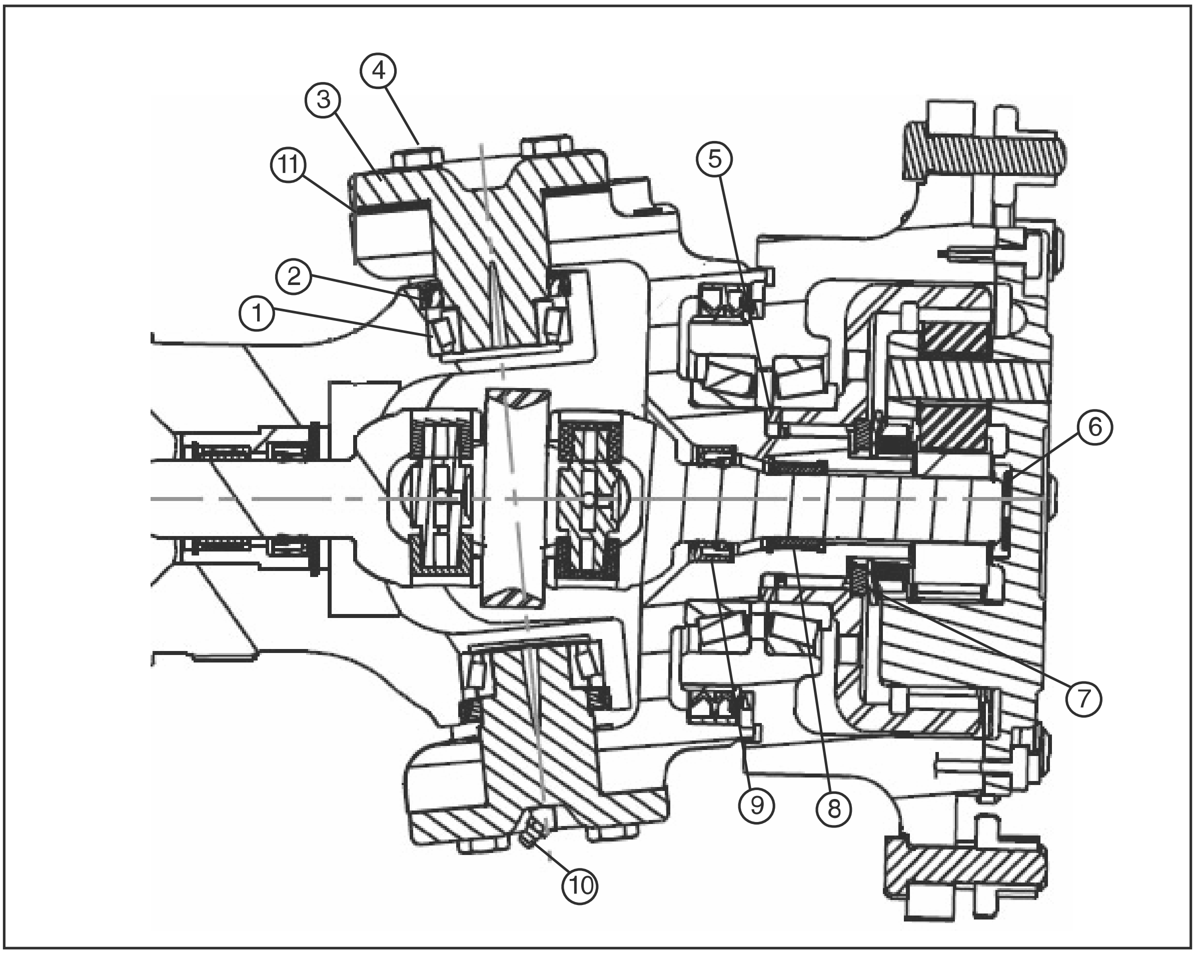


Fig 2a Four wheel drive Front axle (Wheel end cut section)

1. Taper roller bearing.
2. Oil seal
3. King pin.
4. Bolts.
5. Hub spacer.
6. Thrust washer.
7. Spacer.
8. Needle roller bearing .
9. Oil seal.
10. Grease nipple.
11. King pin shim

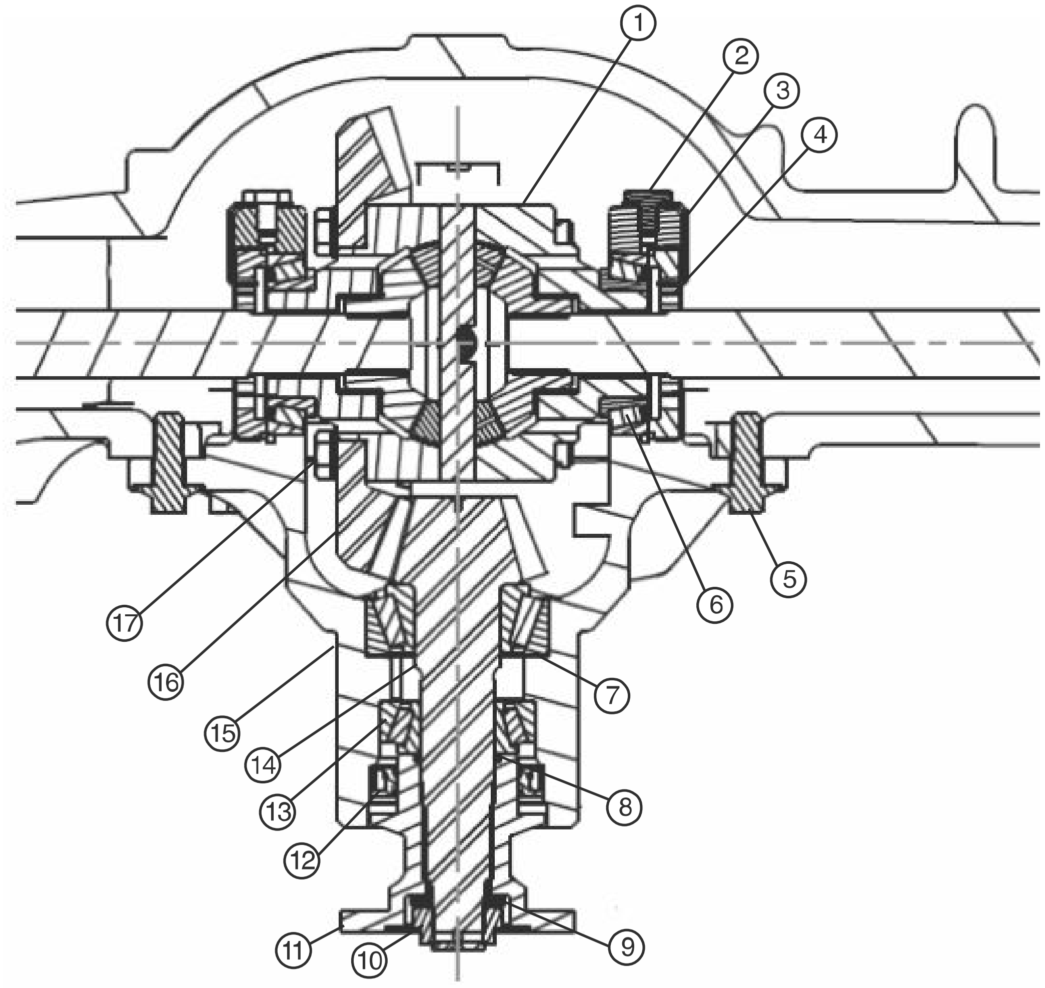


Fig 3 Four wheel drive Front axle (Differential cut section)

1. Differential case assembly.
2. Bolt.
3. Locking plate.
4. Ring nut.
5. Differential carrier bolt.
6. Taper roller bearing.
7. Shim.
8. ‘O’ ring.
9. Washer.
10. Castle nut.
11. End flange.
12. Oil seal.
13. Taper roller bearing.
14. Pinion.
15. Differential carrier.
16. Crown wheel.
17. Differential case bolts

7B - 3 WHEEL ALIGNMENT AND STEERING STOPS

Adjust

Procedure - wheel alignment

1. Drive the tractor onto firm level ground and put the front wheels in the straight ahead position.
2. Check the wheel toe-in measured on the centre line of the axle at the tire. Distance ‘A’ must be 0 - 0.196 inch (0 - 5 mm) greater than distance ‘B’.
3. If adjustment is necessary, slacken the locknut (1) on the track rod on both sides.

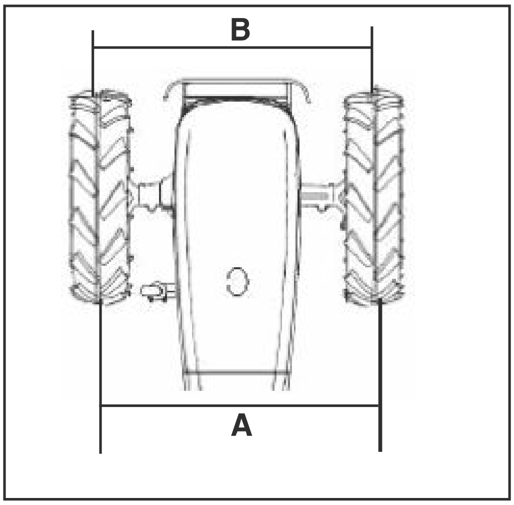


Fig 4

4. Rotate the inner steering ball joint (2) to either increase or decrease the track rod length to obtain the correct toe in.
5. Apply Massey Ferguson Stud lock (Loctite 118) and tighten the track rod lock-nut to a torque of 81 - 88 lbf.ft (110 - 120 Nm).

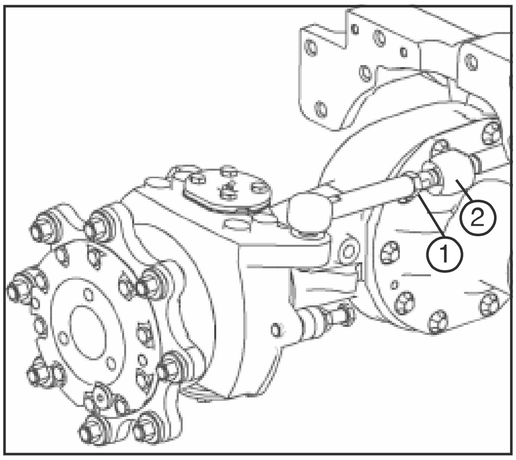


Fig 5

Procedure - steering stops

CAUTION: ***At the smaller track settings, a foul condition may occur between the tire and tractor or loader, if fitted, when the wheels are turned to the full lock position. To avoid this condition you must check by turning the wheels to full lock and adjusting the steering stops as necessary.***

6. Place the jack under the engine sump and raise the tractor enough to allow the axle to swing from one stop to the other.
7. Turn the front wheels to full lock and check that the inside edge of the tire does not foul the tractor.
8. Carry out the same check on the other lock.
9. If necessary, adjust the length of the steering stops (1) on both sides so that a foul condition will not occur. Tighten the lock-nuts (2) to a torque of 88 - 95 lbf.ft (120 - 130 Nm) after adjustment.

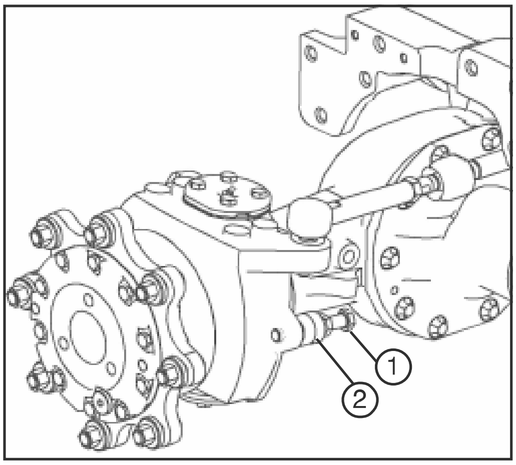


Fig 6

7B - 4 TRACK ROD AND BALL JOINT

Removal and refitment

Removal

1. Remove the nut from the ball joint.
2. Remove the ball joint from the housing by using an extractor or by striking the housing with a hammer adjacent to the ball joint to release the taper.
3. Slacken the lock-nut and unscrew the ball joint from the track rod.
4. To remove the inner joint, hold the end of the steering ram piston rod with a spanner and unscrew the joint.

Refitment

5. Reverse procedures 1 to 4 except:

   a. Apply Massey Ferguson Stud lock (Loctite 118) to the threads of inner joint and screw it into the end of the steering ram piston rod.

   b.Set the wheel alignment as described in operation 7B - 3.

   c. Tighten the track rod lock-nut to a torque of 81 - 88 lbf.ft (110 - 120 Nm).

   d. Apply loctite 118 to the thread and tighten the ball joint nut to a torque of 114 - 125 lbf.ft (155 - 170 Nm).

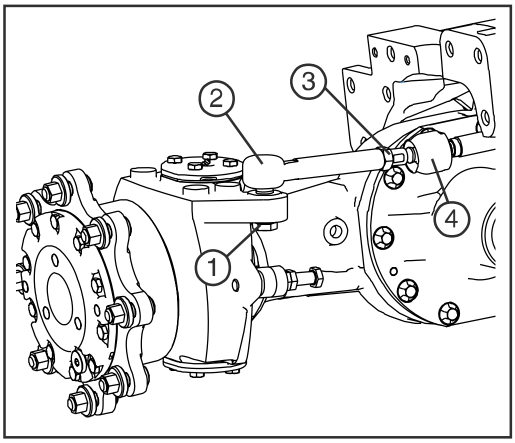


Fig 7

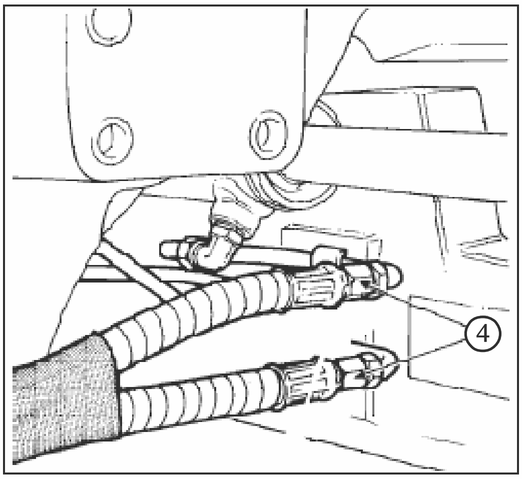


Fig 8

7B- 5 FRONT AXLE

Removal and refitment

Special Tools:

MF 485 / 1	Pivot Pin Seal Installer
MF 444	Axle pivot pin remover

Removal

1. Place a floor jack under the engine sump and take the weight of the front of the tractor. DO NOT lift the front wheels off the ground.
2. Remove the front weights, if fitted.
3. Remove the front weight frame.
4. Disconnect the steering ram hoses at the cylinder end. Cap the ends of the pipes and hoses to prevent the ingress of dirt.
5. Disconnect the front axle propeller shaft guard.
6. Disconnect the propeller shaft.
7. Remove the Battery tray from the tractor.
8. Remove the axle pivot pin. If difficulty is experienced in removal, use special tool MF 444 to extract the pin from the front support.

⚠ **WARNING: Prevent the axle from tilting or rotating about the wheels if the axle is wheeled from under the tractor on its wheels. It could cause injury if precautions are not taken.**

9. Jack up the front of the tractor so that the axle can be wheeled out from under the tractor.

   or

   Remove the wheels, and with the aid of a crane, sling the axle on ropes and lift out from under the tractor.
10. Recover the two seals and thrust washers located each side of the axle pivot.
11. Place the axle on two axle stands and remove the wheels.

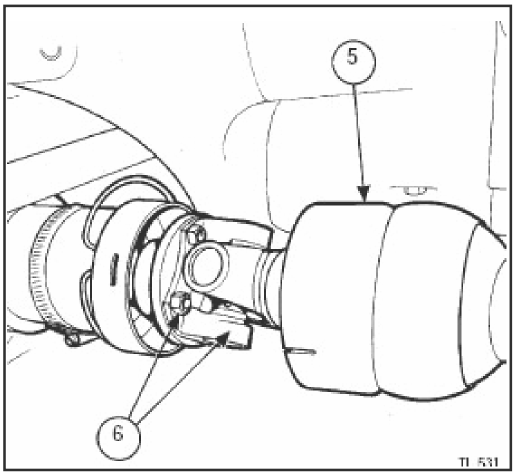


Fig 9

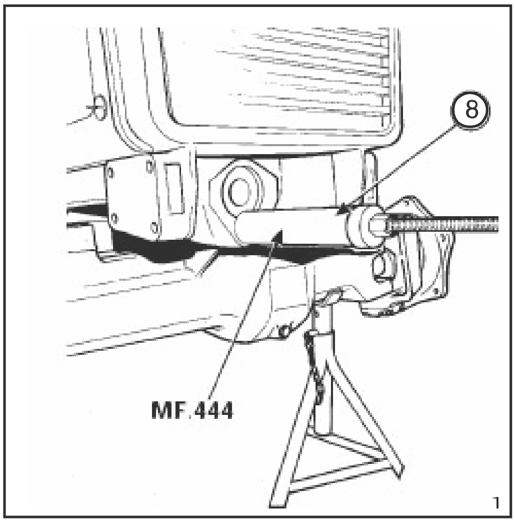


Fig 10

Refitment

12. The axle pivot pin is fitted with two dirt seals at the front and back between the axle and the support casting.
13. With the aid of an overhead crane sling the axle so that it is horizontal in both directions. Place the axle under the front support casting.
14. Carefully lift the front axle up into position under the tractor. DO NOT damage or move the seal assembly fitted to the rear pivot pin hole.
15. Align the pivot pin hole. Part fit the pivot pin as shown in the illustration. DO NOT push the pivot pin right in.
16. Take the second seal and assembly tool MF 485 / 1 Pivot Pin Seal Installer.

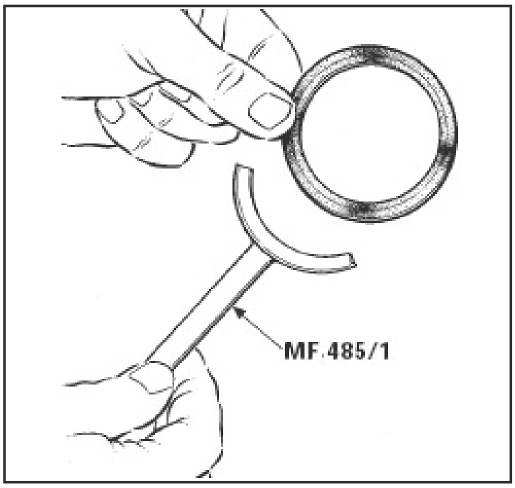


Fig 11

17. Squeeze the lips of the seal together and carefully fit it into the groove in the seal installer.

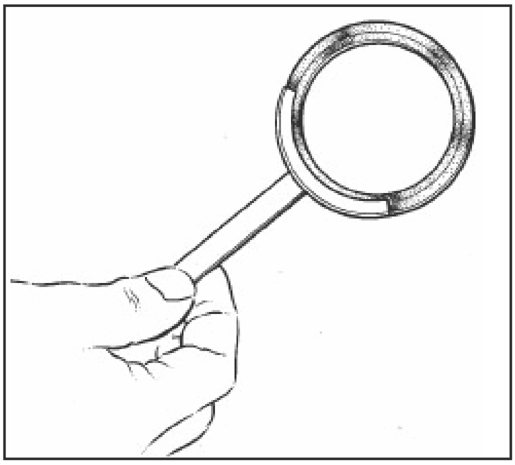


Fig 12

18. Install the steel washer inside the seal holding it in place with a little grease.

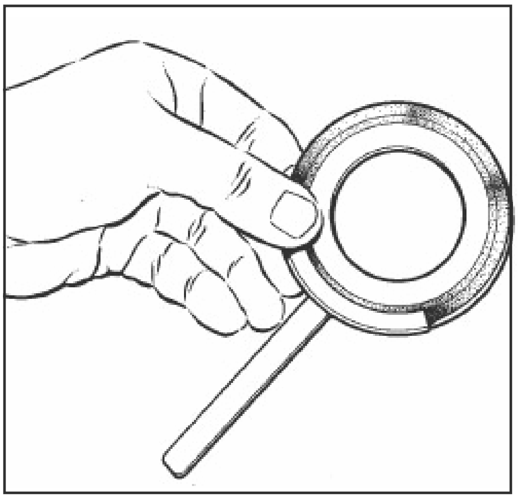


Fig 13

19. Holding the axle in place so that it does not move, remove the pivot pin.
20. Slide the seal, washer and tool assembly into position from right to left leading with the handle as shown in the illustration. DO NOT use the handle to pull it into place.
21. When the hole in the seal and washer assembly, axle and front support casting are in line, replace the pivot pin.
22. Push the pivot pin right in, this will push out the rear plastic plug used to hold the rear seal assembly in place.

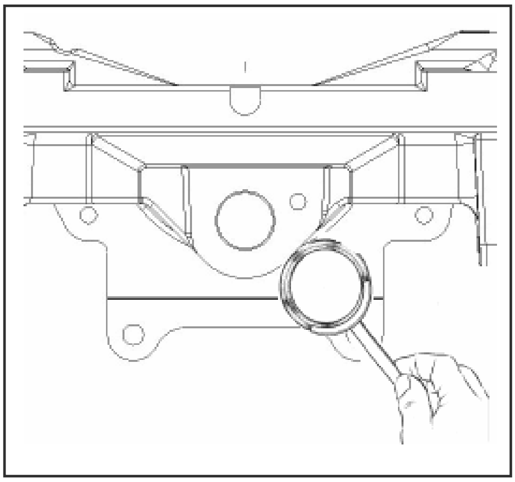


Fig 14

23. When the pivot pin has been installed remove the tool by pulling it away from the seal with the handle.
24. Reverse procedures 1 to 8 except:

    a. Grease the axle pivot pin.

    b.Check steering function to ensure that hydraulic hoses to the steering ram have been correctly connected up.

    c. Check that the steering hoses are correctly routed to prevent chaffing on sharp edges.

    d. Check the power steering pump oil level, if fitted to this tractor, and remove air from the system.

7B - 6 PLANETARY CARRIER

Removal and refitment

Removal

1. Apply the parking brake and secure the rear wheels.
2. Raise the tractor under the side of the axle to be worked on, then support the axle on an axle stand and remove the wheel.
3. On all footstep tractors with four-wheel drive engagement, disconnect the propeller shaft.
4. Rotate the hub until the plug is at the bottom.Remove the wheel and the plug (8 mm hexagon key will be required) and drain the oil from the hub.
5. Mark the position of the planetary carrier in relation to hub to assist alignment during refitment.
6. Remove the 10 cap screws in the planetary carrier.
7. Remove the planetary carrier.

Refitment

8. Reverse procedures 1 to 7 except:

   a. Apply Massey Ferguson Instant Gasket (Loctite 596) to the hub face.

   b. Apply a light coating of loctite 118 to the planetary carrier bolts or cap screws. Tighten the bolts to a torque of 60 - 70 Nm (44 - 51 lbf.ft).

   c. Rotate the wheel so that the plug is horizontal. Fill the hub to this specified level with an approved oil and refit the plug.

   d. Tighten the wheel nuts to a torque of 199 lbf.ft (270 Nm).

   e. Reconnect the propeller shaft.

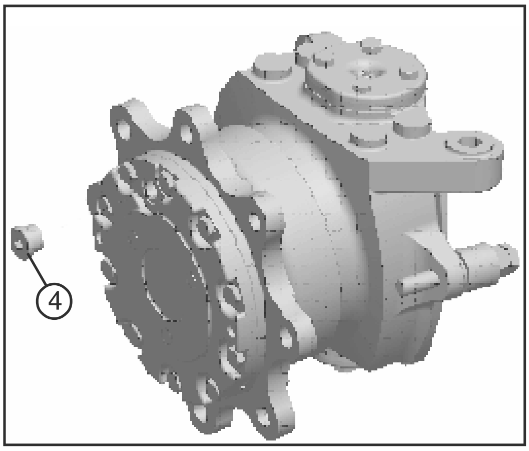


Fig 15

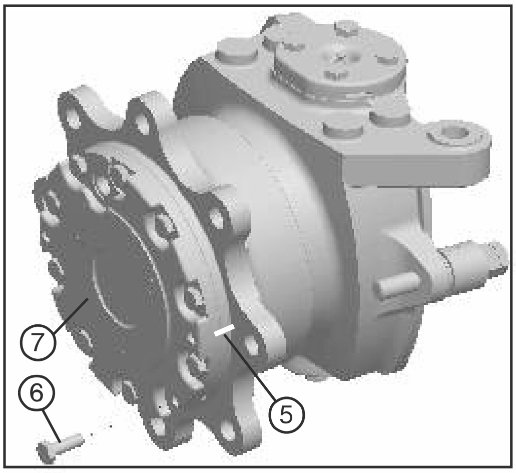


Fig 16

7B - 7 PLANETARY CARRIER

Over hauling

Special Tools :

SER / 316 Pusher to press the pinion planetary

Removal

1. Apply the parking brake and secure the rear wheels.
2. Raise the tractor under the side of the axle to be worked on, then support the axle on an axle stand and remove the wheel.
3. Remove the planetary carrier refer operation 7B - 6
4. Tap the pin planetary (1) with suitable rod.
5. Remove the planetary gear (2) with needle roller (3).
6. Remove the thrust washer (4).
7. Repeat the procedure 4 to 6 for removal of remaining gears.

Refitment

8. Reverse procedures 1 to 7 except:

   a.Press the pin planetary by using SER / 316.

   b.Apply Massey Ferguson Instant Gasket (Loctite 596) to the hub face.

   c.Apply a light coating of loctite 118 to the planetary carrier bolts or cap screws. Tighten the bolts to a torque of 44 - 52 lbf.ft (60 - 70 Nm).

   d.Rotate the wheel so that the plug is horizontal. Fill the hub with specified quantity of oil and refit the plug.

   e.Tighten the wheel nuts to a torque of 199 lbf.ft (270 Nm).

   f. Reconnect the propeller shaft.

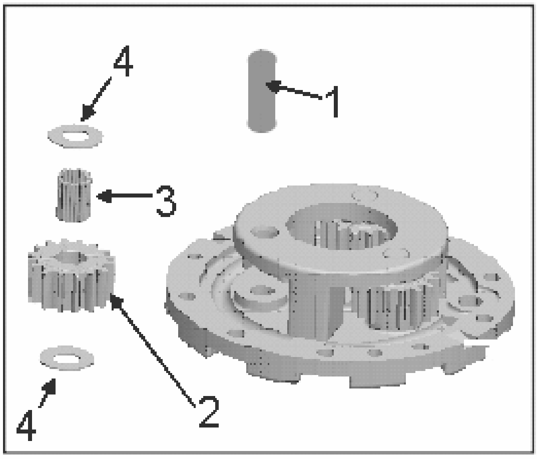


Fig 17

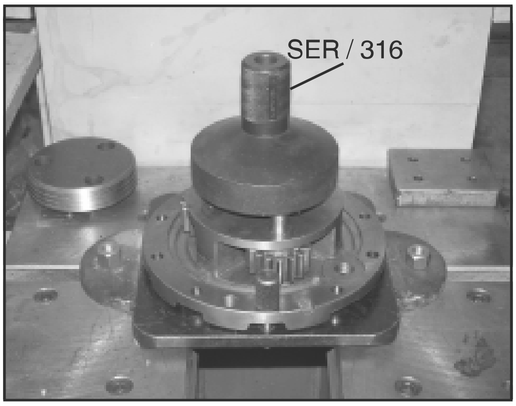


Fig 18

7B- 8 HUB OIL SEAL

Removal and refitment

Special tools:

SER / 315 - Torque wrench socket

SER / 310 - Oil seal presser.

SER / 314 - Press cone bearing in annular gear

SER / 311 - Press to bearing cup in inner wheel hub

1. Remove the planetary carrier, see operation 7B - 6.
2. Remove the circlip (1) and sun gear (2) from the wheel hub.
3. With a narrow cold chisel and mallet carefully unstake the tab washer (3) from lock nut (4).
4. Using special tool SER / 315 remove the lock nut.

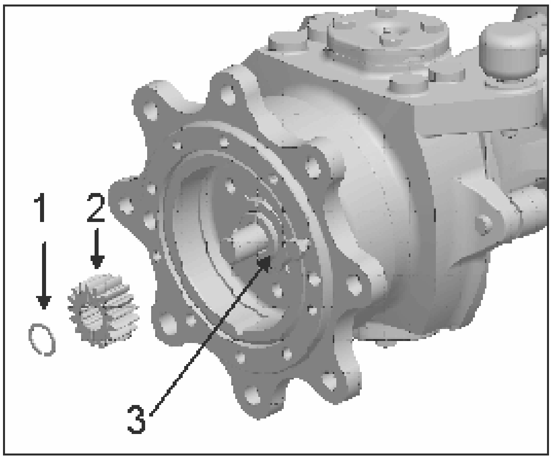


Fig 19

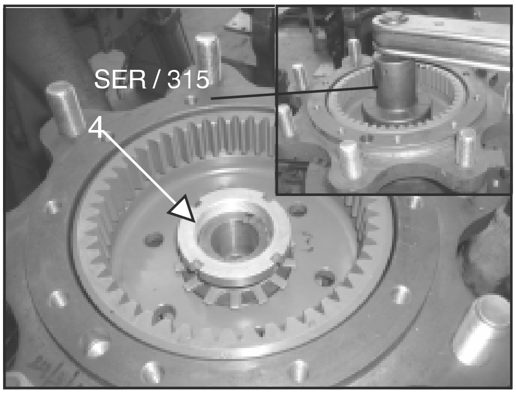


Fig 20

5. Remove the tab washer and spacer.

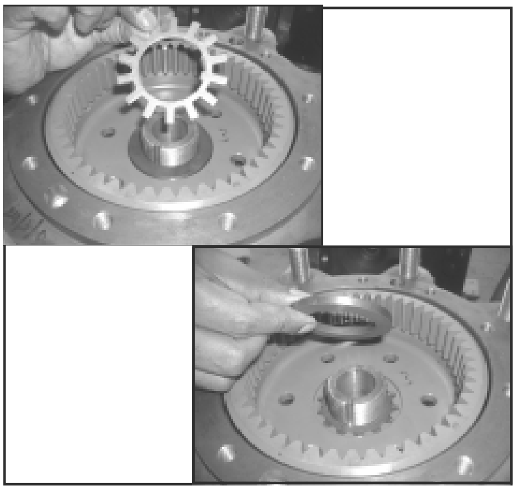


Fig 21

6. Remove the annular ring gear, hub spacer and wheel hub from the swivel housing. If necessary remove the two bearing cups and cone using puller.

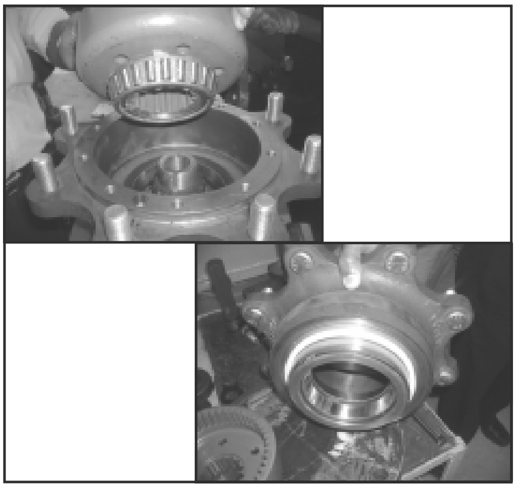


Fig 22

7. Remove the dirt seal from the back of the hub.
8. With a screw driver , remove the large seal and remove from the housing.
9. Check for any visual damages , if any before assembly.

   IMPORTANT: *Apply loctite 118 in all the threads of the forcing screw .*

10. Clean all components for reassembly.

Refitment

11. Fit a bearing cone into the swivel housing and fit a cup into the wheel hub using SER / 311 and ensure zero gap.
12. Using special tool SER / 310 Hub Seal Installer fit a new oil seal. Place the seal on the tool with the lip facing outwards.
13. Offer the seal and tool assembly up to the swivel housing, with a hammer, gently drive the seal into the housing.
14. Fit the a new oil seal wear ring using a mallet. Drive the wear ring down onto the hub using the same method when fitting the oil seal.

    NOTE: *The radius edge of the wear ring must face outwards.*

16. Renew the dirt lip seal on the back of the hub.
17. Fill the space between the dirt seal and the lip seal with general purpose grease. It must be 30 to 50% full. Also apply generous application grease to the lips of the seal.
18. Replace the hub.

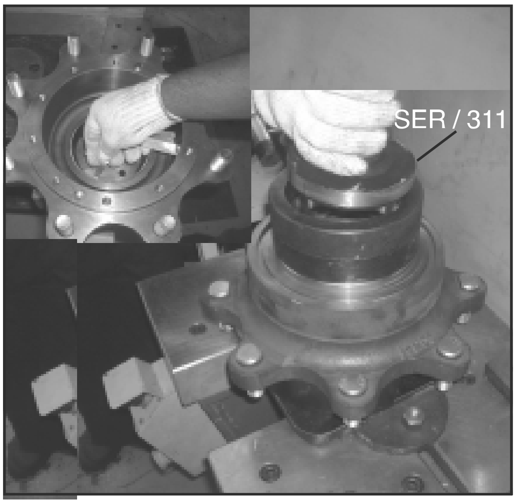


Fig 23

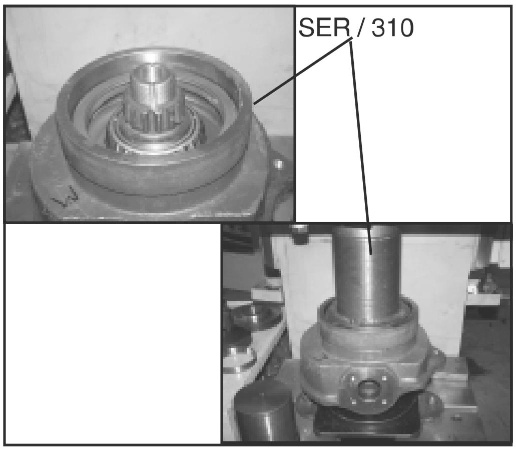


Fig 24

19. Replace the annular ring gear bearing cone by using SER / 314.
20. Slide the wheel hub assembly into position.
21. Push the wheel hub into the oil seal.
22. Replace the hub spacer.
23. Replace the annular ring gear.
24. Replace the spacer.
25. Replace the tab washer.

    IMPORTANT: *Aplly loctite 118 in all the threads of the forcing screw.*

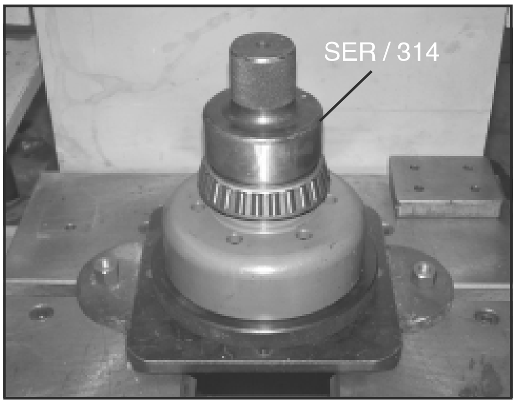


Fig 25

26. Replace the lock nut and tighten dry to a torque of 250 - 258 lbf.ft. (340 - 350 Nm) using SER / 315
27. Check the end float of wheel hub with respect to swivel housing . The recommended end float is 0.039 - 0.0118 inch (0.1 to 0.3 mm) . If the end float exceeds recommended specification loosen the retaining nut and select the suitable hub spacer and ensure the end float is 0.039 - 0.0118 inch (0.1 to 0.3 mm) .

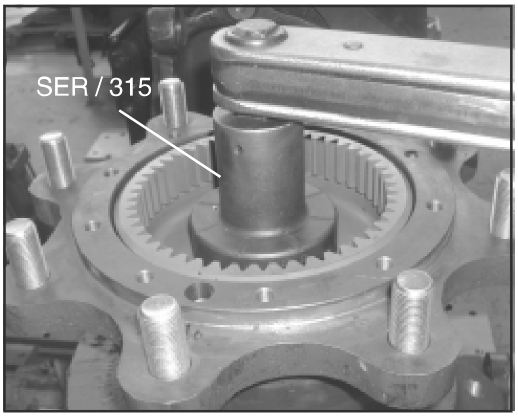


Fig 26

SL.NO	Part Number	"X"+/- 0.002inch (0.05 mm) Thickness	
		mm	Inch
1	2214C01801	5.90	0.2323
2	2214C01901	6.00	0.2362
3	2214C02001	6.10	0.2402
4	2214C02801	6.20	0.2441
5	2214C02901	6.30	0.2480
6	2214C03001	6.40	0.2520
7	2214C03101	6.50	0.2559
8	2214C03201	6.60	0.2598
9	2214C03301	6.70	0.2638

28. Fold two tabs of tab washer into slot lock nut.
29. Replace the sun gear and circlip.
30. Replace the planetary carrier.

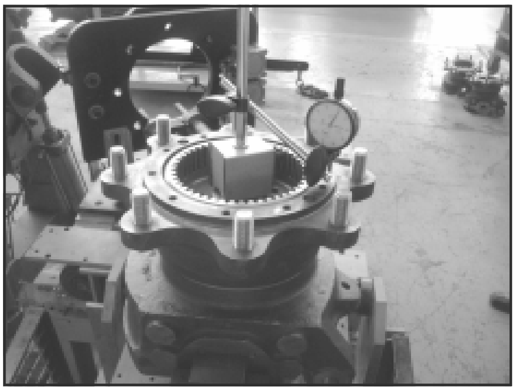


Fig 27

7B - 9 SWIVEL HOUSING AND PINS

Removal and refitment

Special Tools:

SER / 309	Bearing Puller - Main Tool.
SER / 308	Press needle roller bearing into the swivel housing
SER / 319	Pusher to press cup bearing in king pin bores.
SER / 320	Pusher to press oil seal in king pin bores

Removal

1. Remove the steering ball joint nut.
2. Release the steering ball joint from the swivel housing.
3. Remove the planetary carrier refer operation 7B- 6.
4. Remove the Wheel hub refer operation 7B - 8.
5. Remove the four bolts from the king pin from top and bottom.
6. Using screw driver pull the king pin until it comes out from axle.
7. Remove the king pins from the swivel housing.
8. Remove the king pin shims.
9. Remove the swivel assembly from the axle.
10. Remove the oil seal from the swivel housing.
11. Remove the circlip.
12. Remove the needle roller bearing
13. Remove the oil seal in the axle housing.If necessary remove the bearing cup in axle housing.

    IMPORTANT: *Lubricate all the threads of the forcing screw.*

Examination

Thoroughly clean and inspect all components and renew any that are worn or damaged. Renew all seals.

Refitment

14. Renew the seals on the axle housing using SER / 320 and swivel housing and refit the bearing cone by using SER/ 309.Install the needle roller bearing into the swivel housing using SER / 308.
15. Fit the bearing cones to the king pins and cups in axle housing bores using SER / 319. DO NOT grease the bearings at this stage.

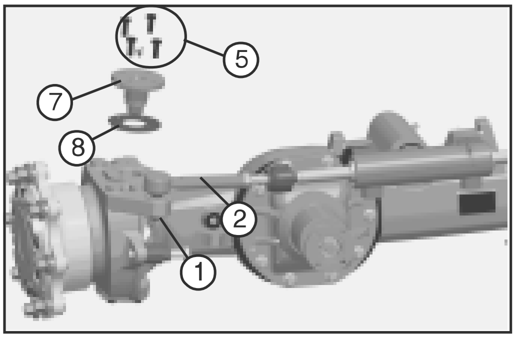


Fig 28

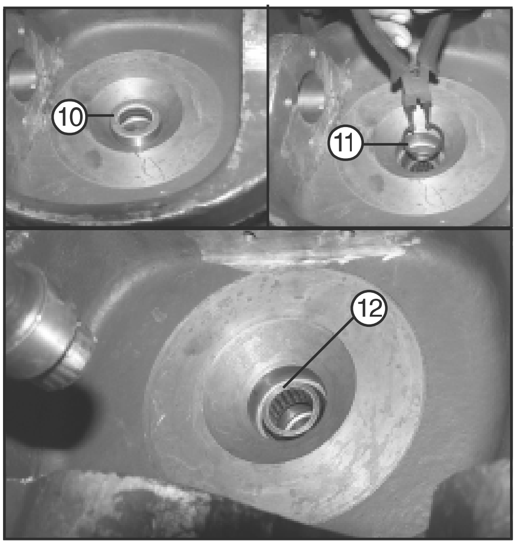


Fig 29

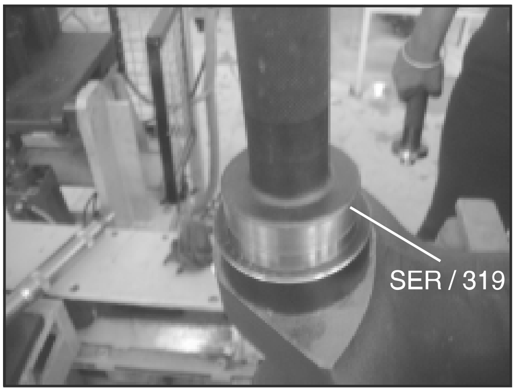


Fig 30

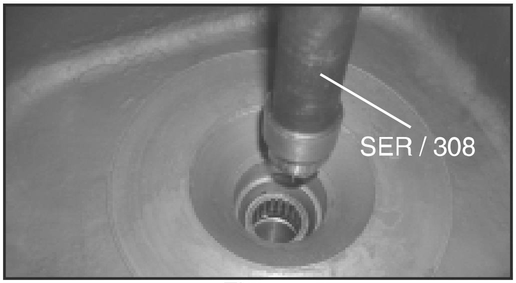


Fig 31

16. Coat the king pins and holes with a light application of grease.
17. Hold the swivel housing in position and partly fit the upper king pin to locate the assembly.
18. Refit the lower king pin, bearing cup, and bolts. NO shims are fitted to the lower king pin and also insert the dummy king pin on top and lightly tapping it by using mallet.
19. Tighten all the four bolts evenly and in sequence to pull the lower king pin into the housing. Tighten the four bolts to a torque of 44 - 51 lbf.ft (60 - 70 Nm).
20. Hand tight the top side two bolts with spanner.
21. Ensure that both king pins are fully seated onto the axle casing.
22. Check the gap between swivel housing and king pin by using feeler gauge.
23. Select shims such that the gap is 0.0059 inch (0.15 mm) maximum.
24. Remove the dummy king pin and bearing cone. Fill the bearing with grease, fit the correct number of shims, replace the king pin.
25. Apply loctite 118 to the threads of the bolts and tighten to a torque of 44 - 51 lbf.ft (60 - 70 Nm).
26. Remove the lower king pin and cone and fill the bearing with grease. Tighten the bolts as described in procedure 19.
28. Grease both bearings with a grease gun to ensure that they are full.
29. Apply loctite 118 to the thread and tighten the ball joint nut to a torque of 114 - 125 lbf.ft (155 - 170 Nm).

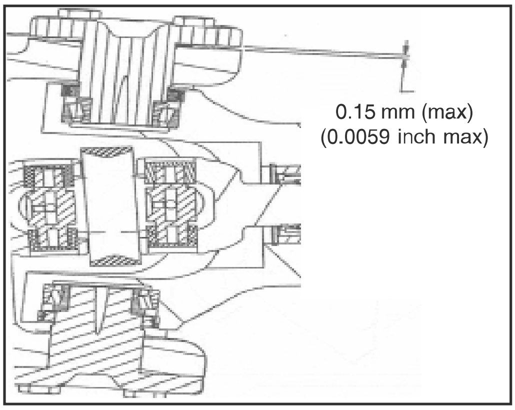


Fig 32

SL.NO	Part Number	Thickness "X"	
		mm	inch
1	4256224M1	0.13 +/- 0.02	0.0051 +/- 0.0008
2	4256225M1	0.25 +/- 0.03	0.0098 +/- 0.0012
3	4256226M1	0.50 +/- 0.03	0.0197 +/- 0.0012

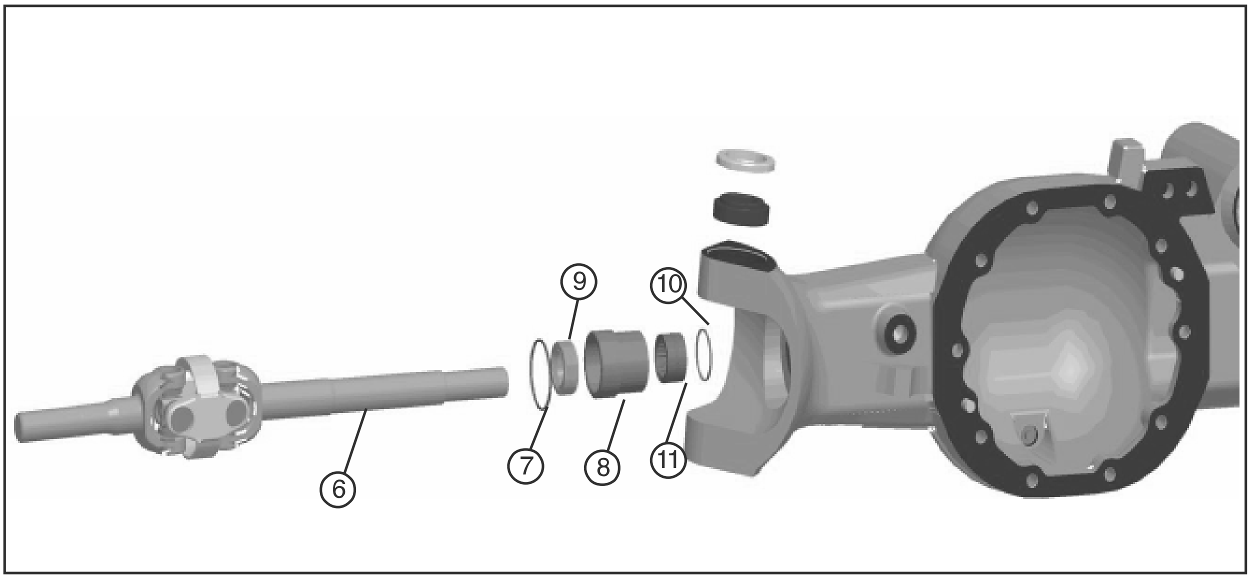


Fig 33

7B - 10 DRIVE SHAFT AND OIL SEALS

Removal and refitment

Special tools :

SER / 317	Press needle roller bearing into the sleeve assembly.
SER / 318	Press oil seal into the sleeve assembly.
SER / 360	Drive shaft end float checking tool

Removal

1. Drain oil from the axle housing.
2. Remove the planetary carrier, see operation 7B - 6.
3. Remove the circlip and sun gear.
4. Remove the wheel hub see operation 7B - 8.
5. Remove the swivel housing, see operation 7B - 9.
6. Remove the drive shaft from axle casing.
7. Remove the circlip by using suitable circlip plier.
8. Remove the sleeve assembly by using suitable extractor
9. Lever the seal out of the sleeve assembly.
10. Remove the internal circlip.
11. Remove the needle roller bearing.

Examination

Carefully inspect the universal joints in the drive shaft, if there is any sign of wear renew the joints or fit new shafts. Inspect the condition of the drive *sleeve, renew if necessary.*

Refitment

12. To install needle roller bearing using SER / 317,circlip and oil seals into the sleeve assembly using SER / 318 . It will be necessary to make two service tools. This will ensure that the components are correctly fitted.

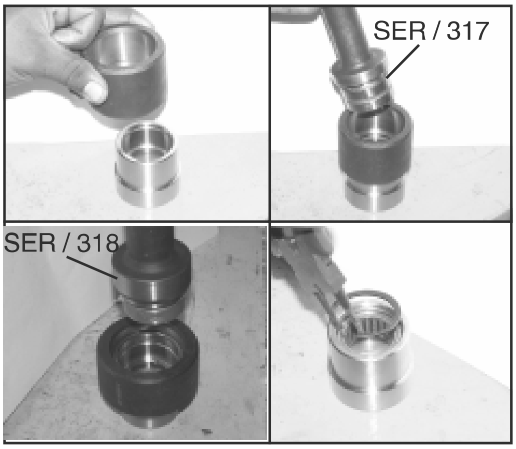


Fig 34

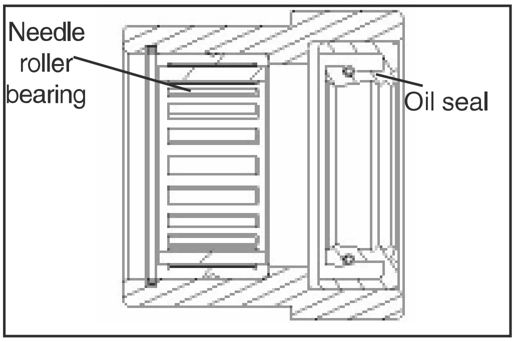


Fig 35

13. Place the sleeve assembly and drive it into the housing and secure with circlip.
14. Drive the sleeve assembly into the axle housing and secure with circlip (1).

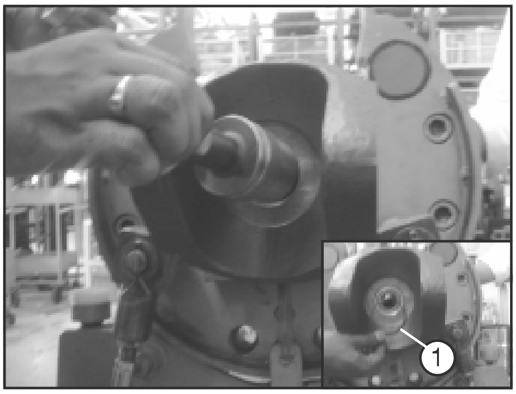


Fig 36

15. Fill the seal cavity with a multi purpose grease.
16. Refit the drive shaft into the axle housing taking care not to damage the oil seal when locating the splines.
17. Refit the swivel housing, wheel hub and planetary.

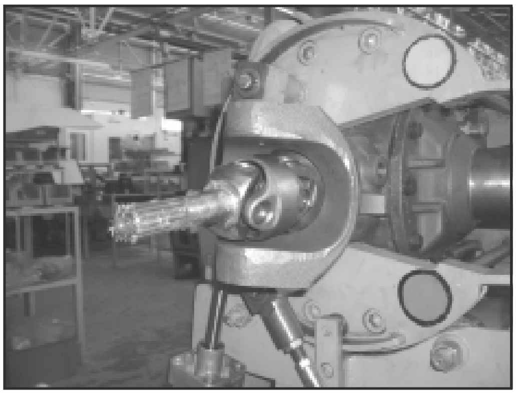


Fig 37

18. Pick the SER 360 drive shaft end float checking tool and fit into the wheel hub and measure gap using feeler gauge.

19. According to the clearance between shaft end and tool. Select the steel washer thickness at higher side refer below table (i.e Drive shaft end float should be 0.011 inch (0.3 mm) max).

SL.NO	Part Number	Thickness “X”	
		mm (+/- 0.05)	inch (+/- 0.0019)
1	2212C01701	2.4	0.0944
2	2212C00601	2.6	0.1023
3	2212C01801	2.8	0.1102
4	2212C01901	3.0	0.1181
5	2212C02001	3.2	0.1259
6	2212C02101	3.4	0.1338

20. Apply grease over the steel washer and place the same inside the planetary carrier.

21. Refit the planetary carrier.

22. Refill the both axle and planetary carrier to the specified level with an approved level of oil.

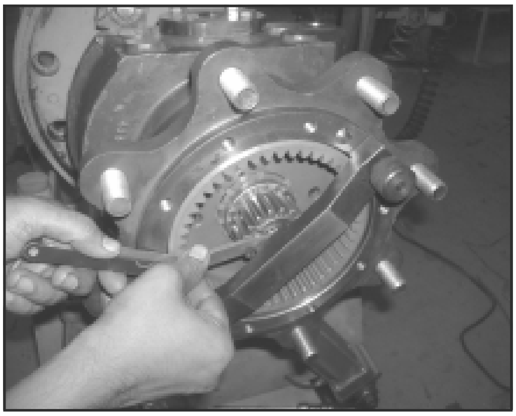


Fig 37 A

7B - 11 DRIVE SHAFT

Overhaul

Dis-assembly

1. Remove the drive shaft, see operation 7B - 10.
2. Hold the inner section of the drive shaft in a soft faced vice.
3. Remove the four circlips from each end of the universal joint.
4. Using a hammer, drive the central yoke downwards until the bearing sleeve protrudes.
5. Clamp the bearing sleeve in a vice and tap the central yoke from the bearing.
6. Remove the opposing bearing sleeve in the same way and remove the outer section of the shaft.
7. Turn the shaft assembly through 90° then repeat procedures 4 to 6 to free the other universal joint from the shaft.
8. Grip the outer section of the drive shaft in a vice and repeat procedures 2 to 7.

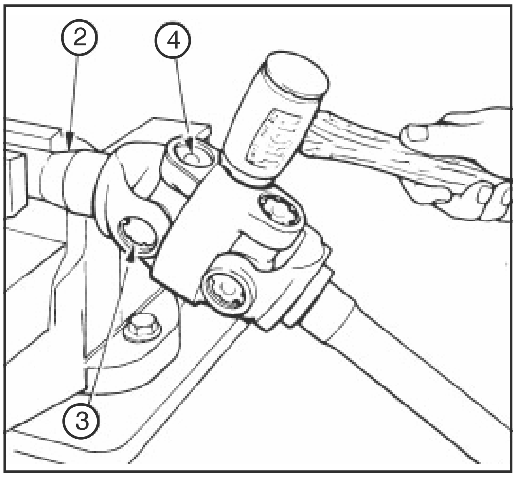


Fig 38

Examination

Pay particular attention to the axle shaft splines. Inspect all components and renew any which show signs of wear or damage. Always renew the universal joint as an assembly including the joint, bearings, caps, circlips and seals.

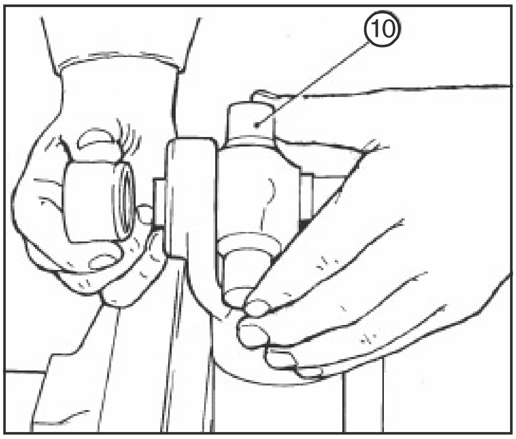


Fig 38

Reassembly

9. Ensure that the needle rollers are held in place. Apply grease in the bearing sleeve.
10. Position the cross within the yoke and move it sideways as far as possible to provide a guide for the needle rollers in the bearing sleeve when being refitted.
11. Slide the bearing sleeve onto the cross and drive the bearing into the yoke deep enough to permit the insertion of the circlip.
12. Assemble the remaining sleeves and universal joint in a similar method.
13. Refit the drive shaft to the axle.

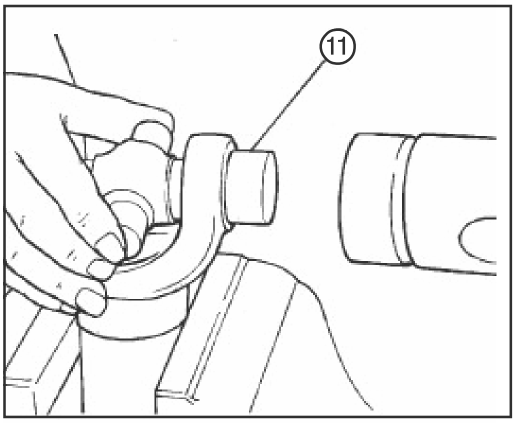


Fig 39

7B - 12 DIFFERENTIAL CARRIER ASSEMBLY

Removal and refitment

Removal

1. Secure the tractor by applying the parking brake.
2. Jack up the front of the tractor and support under the engine.
3. Slide back the propeller shaft guard and disconnect the propeller shaft.
4. Remove the axle from the tractor, see operation 7B - 5.
5. Remove both front wheels.
6. Drain the oil from the axle housing.
7. Remove both swivel housings, see operation 7B - 9 .It is not necessary to dismantle the planetary hubs.
8. Remove the steering ram, see operation 7B - 16.
9. Remove the ten bolts holding the differential carrier to the axle casing.

WARNING: Take care when removing the differential carrier assembly, it is uncomfortable and heavy to handle.

10. The differential is located by dowels in the axle casing. Carefully pry it away from the axle housing supporting the weight at all times.

Refitment

11. Reverse procedures 1 to 10 except:

    a. Apply Massey Ferguson Instant Gasket (Loctite 596) to the joint face of the differential case.

    b. Apply loctite 118 to the differential carrier bolts and tighten them to a torque of 95 - 103 lbf.ft (130 - 140 Nm)

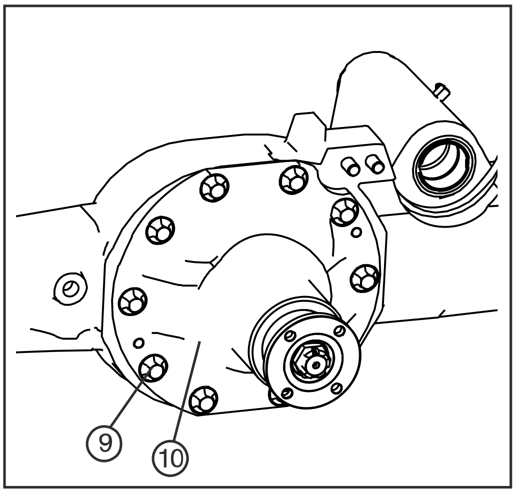


Fig 40

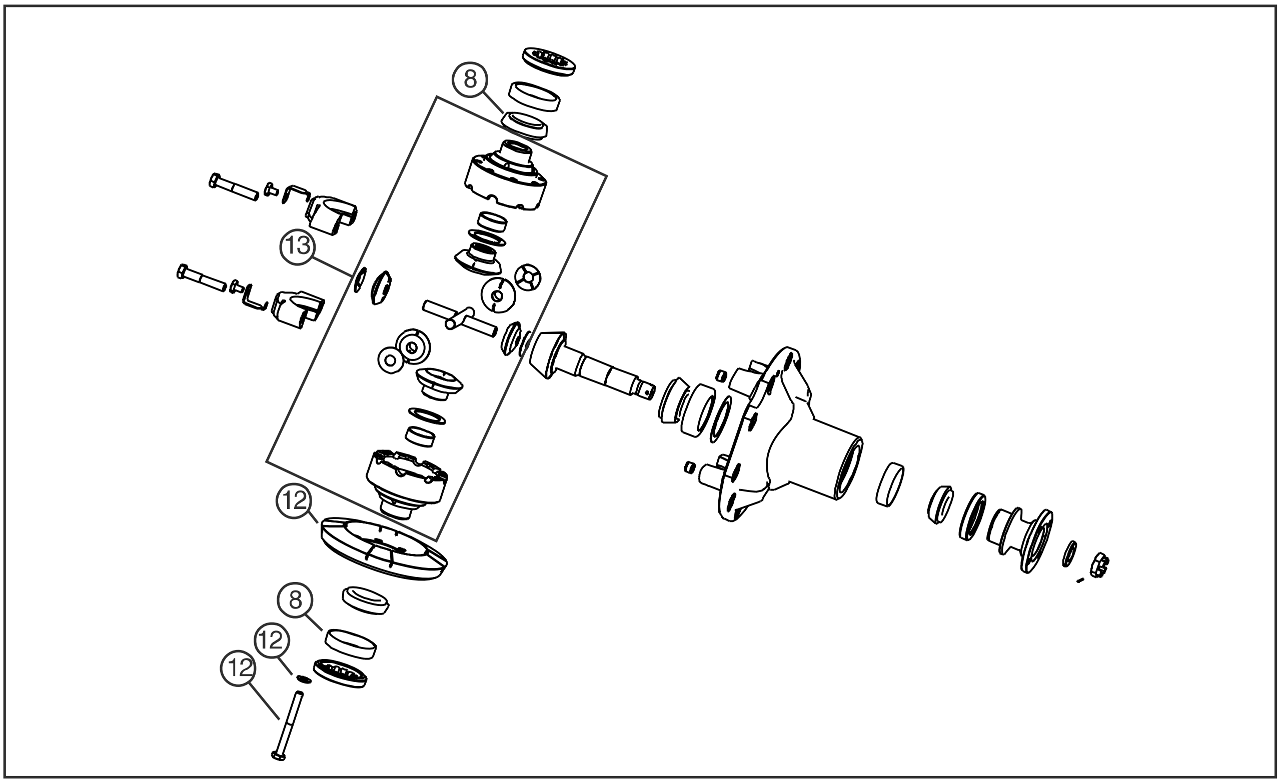


Fig 41

7B - 13 DIFFERENTIAL ASSEMBLY

Overhaul

Special tools :

SER / 300	Press bush in differential case.
SER / 302	Press cone in differential case.
SER / 303	Press crown wheel into the differential case left - hand.

Disassembly

1. Remove the differential assembly, see operation 7B - 12.
2. Hold the differential assembly in the jaws of a vice.
3. Mark the end caps and casting to aid reassembly.
4. Remove the securing bolts.
5. Remove the lock plate.
6. Unscrew the bearing adjustment ring nut.
7. Remove the cap bolts.
8. Remove the bearing caps.
9. Lift the differential assembly out of the differential carrier.
10. Remove the bearing cups.
11. Mark the two halves of the differential case and the crownwheel to aid re-assembly.

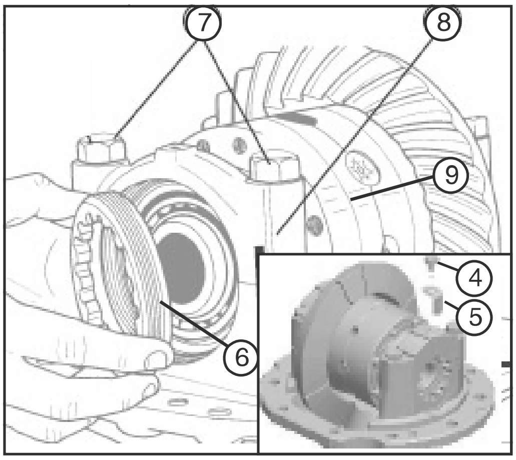


Fig 42

12. Place the crownwheel and differential unit in the vice and remove the wire and 8 bolts and washers.
13. Split the differential case and remove the differential gears, cross pins, thrust washers and crown wheel. Remove the bearing cups and cones.

Examination

14. *Thoroughly clean and inspect all components. Any parts showing signs of wear or damage must be renewed.*

Re-assembly

15. Refit or renew the taper roller bearing cones using SER / 302 if they have been removed.
16. Press the differential bush using SER / 300 and refit the differential gears, cross shaft and thrust washers into the case .
17. Align the previously made marks on the case and press the crownwheel using SER / 303 if the original wheel is being reused. Refit the 8 bolts and washers, apply stud lock (Loctite 118) to the threads and tighten to a torque of 59 - 66 lbf.ft (80 to 90 Nm).Secure the bolts with lock wire.
18. Install the differential case assembly in to the differential carrier.
19. Align the previous made marks on the differential carrier to bearing caps and tap the bearing caps.Ensure the dowel rings are properly seated.
20. Tighten the bearing caps (Hand tighten only).
21. Install the ring nuts on both sides.
22. Turn the left-hand ring nut (Crown wheel side) until the crown wheel contacts the pinion (ZERO Backlash) and then back off by two slots approximately. Ensure ring nuts slots aligns with lock washer mounting hole(Bearing pre load 0.002 to 0.004 inch or 0.05 to 0.1 mm).
23. To preload the differential bearings, fix the dial gauge on the differential carrier face and put the dial gauge stem on the bearing cap of the left-hand side, then screw the ring nut in right-hand side till 0.05 mm (0.002 inch) deflection then if needed further screw up to 0.05 mm (0.002 inch) deflection to align the ring nut slot with lock washer.
24. Measure backlash at three places 120° apart. Make sure it is within specification 0.006 to 0.010 inch (0.15 - 0.25 mm).
25. If you have backlash more than the specification , the crown wheel needs to move closer to the pinion. Loosen the right-hand ring nut (Away from crown wheel) and tight same amount in left hand side ring nut.
26. If you have backlash less than the specification , the crown wheel needs to move away from the pinion. Loosen the left-hand ring nut (near to crown wheel) and tight same amount in right hand side ring nut.

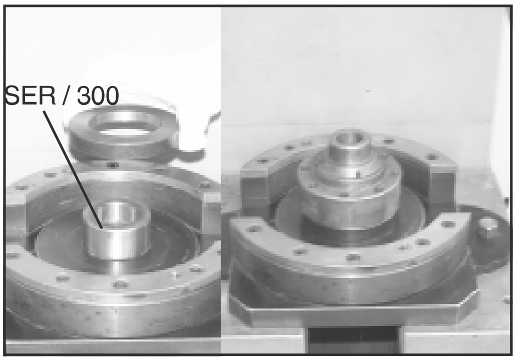


Fig 43

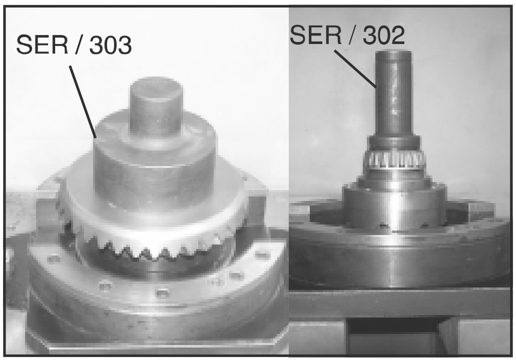


Fig 44

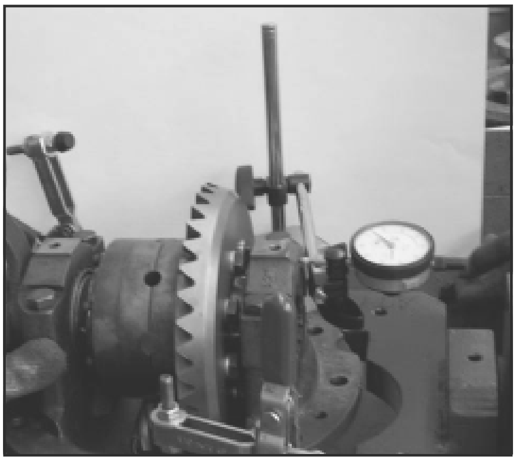


Fig 45

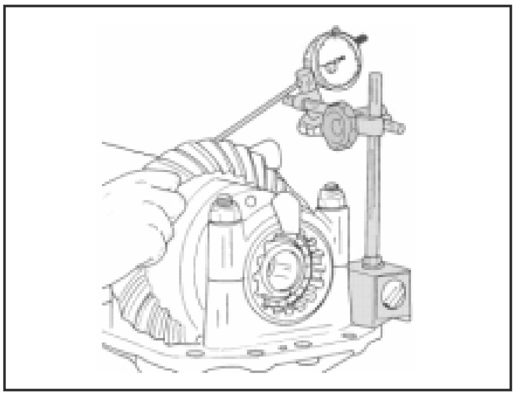


Fig 46

Measuring of crown wheel runout:

27. Measure crown wheel total outer diameter runout (Indicator reading should not exceeds 0.006 inch or 0.15 mm). If runout exceeds more than the specification reject the crown wheel pair and use new pair.

Measuring of crown wheel face runout:

28. Measure crown wheel total face runout (Indicator reading should not exceeds 0.006 inch or 0.15 mm) If exceeds more than the specification disassemble the differential case sub assembly and look for any issues. After reassemble if any problem persists, reject the crown wheel pinion and use new pair.

Contact pattern

29. To check the contact pattern of the bevel gear , paint four tooth of crown wheel in two place at 180° apart.
30. Rotate the pinion with tool both in clockwise and anti clock wise direction.
31. Take the contact pattern by transparent tape from two places 180° apart (Convex side).
32. Paste all pattern in crown wheel pinion assembly record sheet.
33. If contact pattern is like in the illustration 1 , then accept the assembly, other wise adjust as follows.
34. If the pattern is to close to the edge of the tooth toe as in illustration 2, move the crown wheel away from the pinion to increase backlash.

    Loosen the left-hand side ring nut by 1/2 or 1 slot (As required).

    Tighten the right-hand side ring nut by same amount so that differential bearing preload is maintained.

    Recheck the backlash and ensure it is with in specification.
35. If the pattern is concenterated at the heel as in illustration 3, move the crown wheel towards the pinion to decrease backlash.

    Loosen the right-hand side ring nut by 1/2 or 1 slot (As required).

    Tighten the left-hand side ring nut by same amount so that differential bearing preload is maintained.

    Recheck the backlash and ensure it is with in specification.

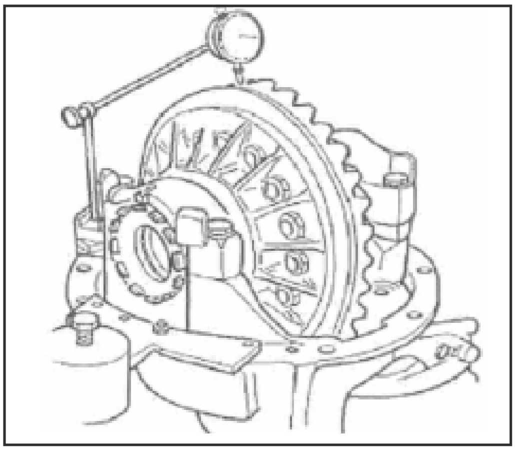


Fig 47

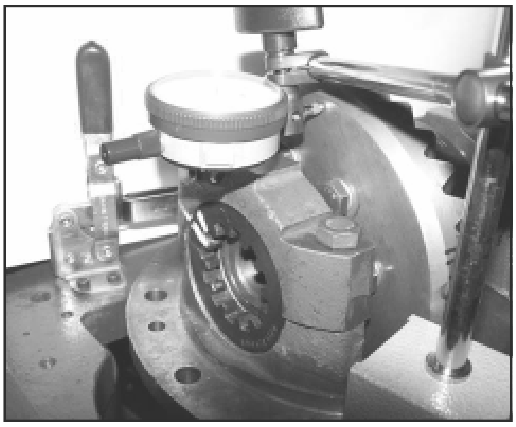


Fig 48

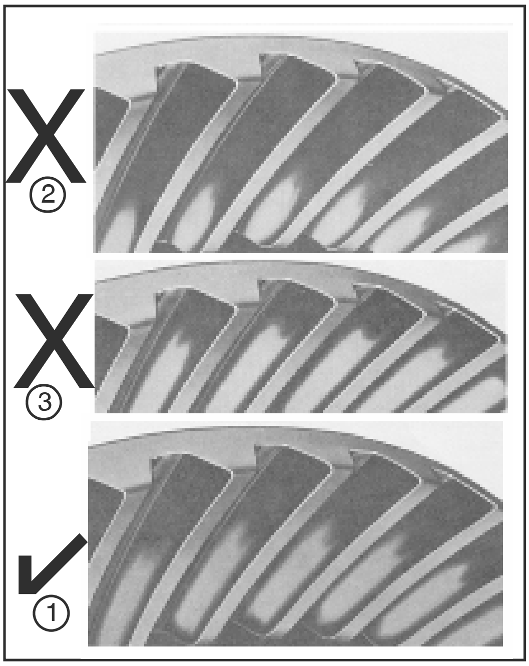


Fig 49

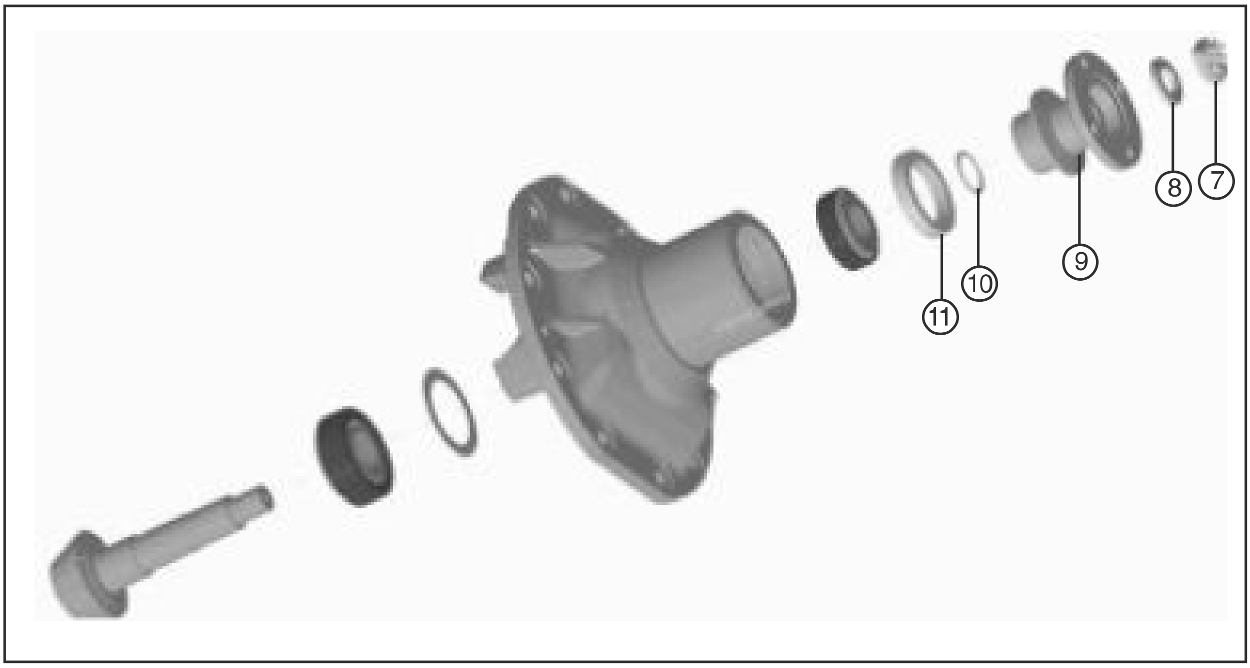


Fig 50

7B - 14 PINION OIL SEAL

Removal and refitment

Special Tools:

SER / 307	Pusher to press oil seal into the differential carrier.

Removal

1. Apply the tractor parking brake.
2. Place a container under the axle housing and drain oil from the axle housing.
3. Slacken the two hose clips and slide back the propeller shaft guard.
4. Slacken the front guard hose clip and slide the guard forward.
5. Remove the four bolts and disconnect the propeller shaft.
6. Unstake the split pin from the castle nut.
7. Using pinion Nut Wrench,remove the pinion castle nut.
8. Remove the washer.
9. Remove the end flange.
10. Remove the ‘O’ ring and discard.

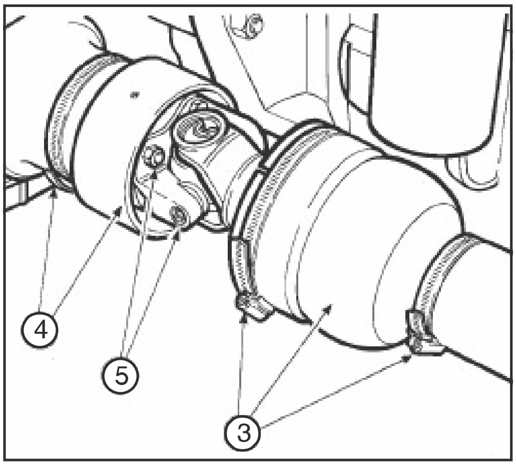


Fig 51

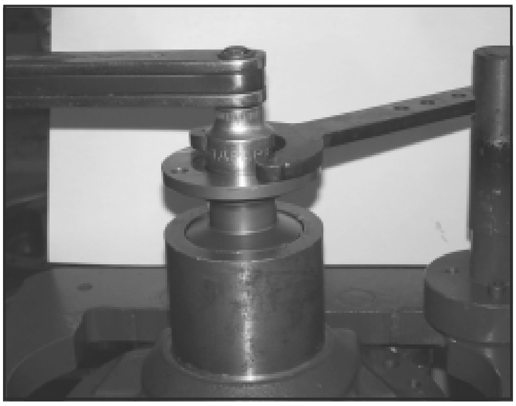


Fig 52

11. Lever the oil seal out of the casing.

Refitment

12. Make the special seal tool as shown in the illustration.
13. Renew the oil seal using SER / 307.
14. Renew the shaft ‘O’ ring.
15. Apply general purpose grease to the cavity of the oil seal.
16. Replace the end flange.
17. Renew the pinion nut and tighten dry to a torque of 66 - 73 lbf.ft (90 - 100 Nm).
18. Align the castle nut slot with hole in the pinion and secure with split pin.
19. Reconnect the Propeller shaft and guard.
20. Refill the axle housing with an approved oil to the specified quantity.

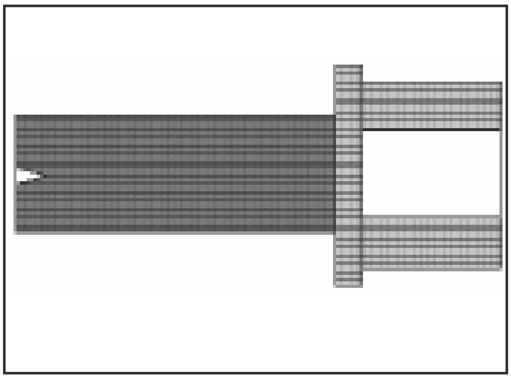


Fig 53

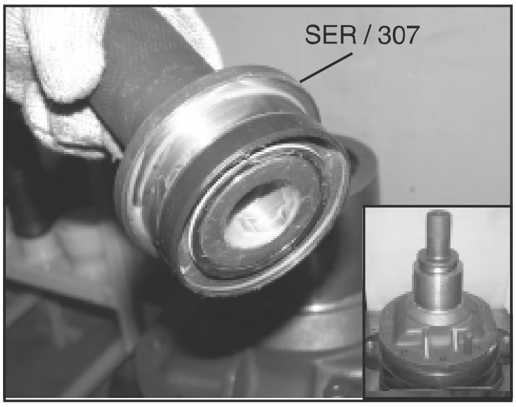


Fig 54

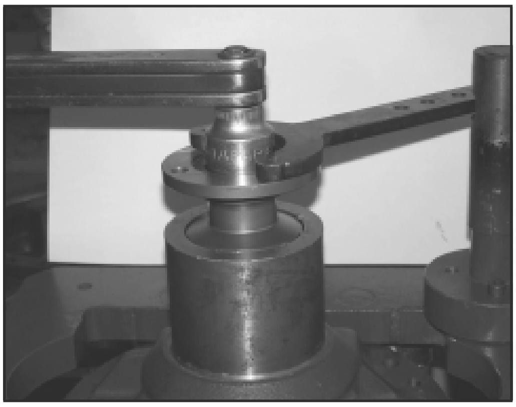


Fig 55

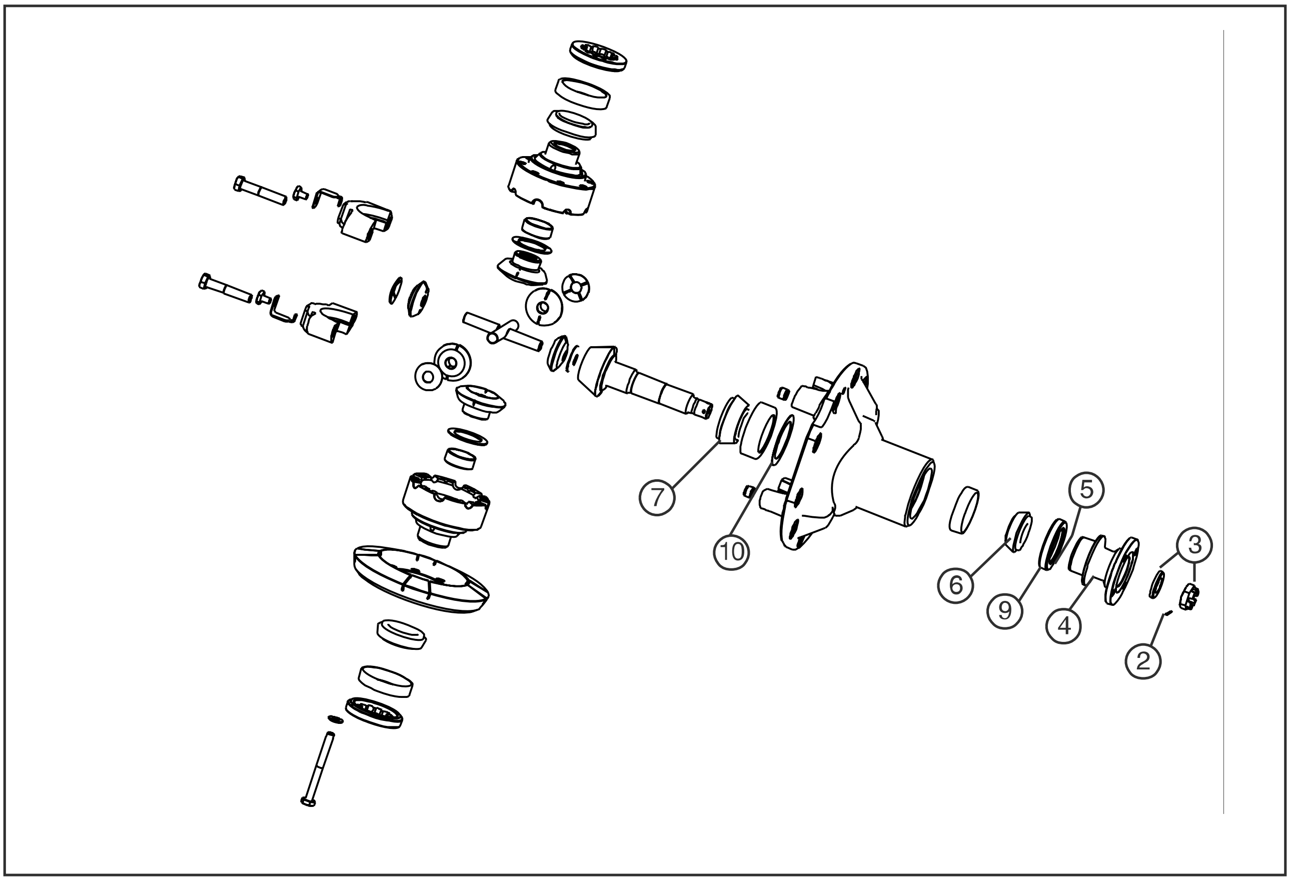


Fig 56

7B - 15 CROWNWHEEL AND PINION

Overhaul

Special Tools:

SER / 304	Press cone into pinion.
SER / 305	Pusher to press bearing cup into inner differential carrier
SER / 306	Pusher to press bearing cup into outer differential carrier.
SER / 307	Pusher to press oil seal into the differential carrier.

Dis-assembly

1. Remove and dismantle the crownwheel and differential assembly, see operation 7B - 12.
2. With a narrow cold chisel and hammer carefully unstake the spilt pin securing it to the castle nut.
3. Using castle Nut Wrench, remove the castle nut and washer .
4. Remove the end flange.
5. Remove the 'O' ring and discard.
6. With the aid of a soft faced hammer or press remove the pinion with bearings from the differential carrier.
7. Remove the outer bearing cone.
8. Remove the inner and outer bearing cups.
9. Remove the oil seal.
10. Remove the bearing pre-load shims and retain for re-assembly.

Examination

Thoroughly clean and inspect all components. Any parts showing signs of wear or damage must be renewed. Renew all 'O' rings, seals and circlips. Ensure that all parts are free from dents or damage.

Re-assembly

The crownwheel and pinion are only available as a matched set. If the crownwheel and pinion are not to be replaced the following instructions on setting the pinion may be disregarded. The two sets of shims must be retained for re-assembly.

It is necessary to carry out a series of measurements and calculations and procedures to establish the exact position of the pinion in relation to the crownwheel and the pinion bearing pre-load. It is recommended that you work in the metric system for ease of calculation.

Pinion settings

12. The height of the pinion is adjusted by shims under the taper roller bearing to obtain dimension. The shims required are calculated in accordance with the following formula:

    Required shim size : A - (B+C)

    A - To be taken from differential carrier stamp.

    B - To be taken from pinion stamp.

    C - Measure the height of taper roller bearing.

		Shim thickness	
S.no	Part number	mm	inch
1	4256108M1	0.08 (+/- 0.01)	0.0031 (+/- 0.0004)
2	4256112M1	0.13 (+/- 0.02)	0.0051 (+/- 0.0008)
3	4256113M1	0.18 (+/- 0.02)	0.0070 (+/- 0.0008)
4	4256114M1	0.25 (+/- 0.02)	0.0098 (+/- 0.0008)
5	4253932M1	0.38 (+/- 0.03)	0.0149 (+/- 0.0012)
6	4253933M1	0.50 (+/- 0.03)	0.0196 (+/- 0.0012)
7	4253934M1	0.80 (+/- 0.05)	0.0314 (+/- 0.0019)

Select the shim nearer to calculated value from above table. More than one shim can be used as per the requirement.

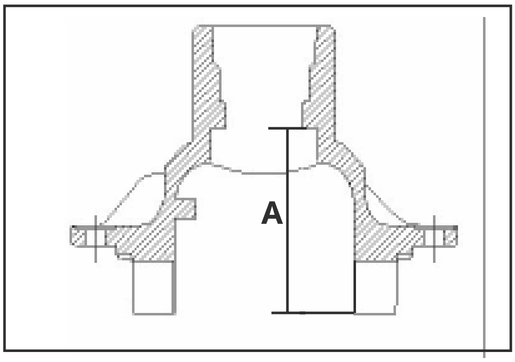


Fig 57

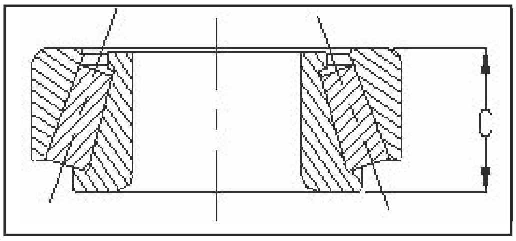


Fig 58

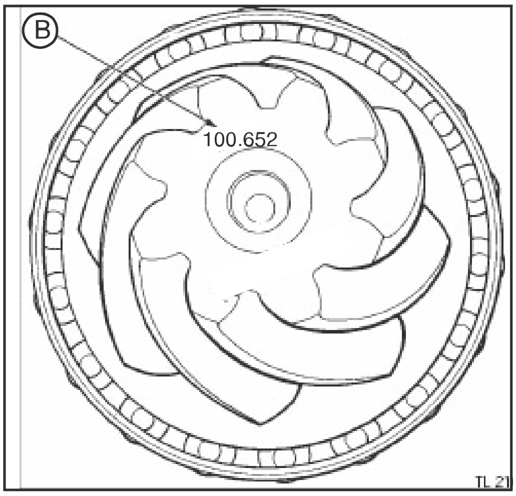


Fig 59

13. Place the suitable shim into the housing and replace the inner bearing cup by using SER / 305 Install another bearing into the differential carrier using SER / 306.

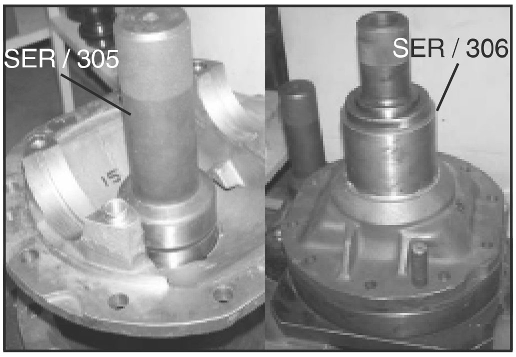


Fig 60

14. Replace the bearing cone into the pinion assembly by using SER / 304.
15. Check the zero gap between pinion face and bearing face by using feeler gauge.

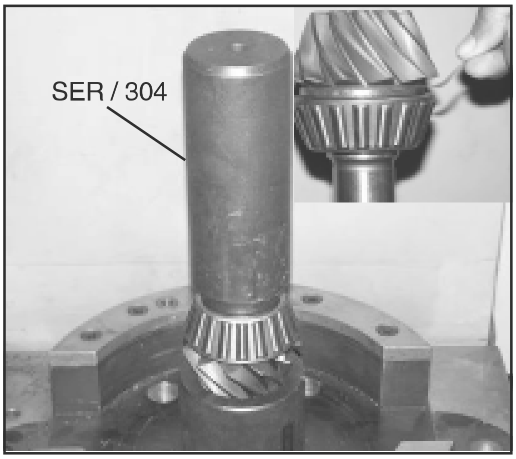


Fig 61

16. Place the pinion assembly into the differential carrier and install the another bearing and press by using SER / 304.
17. Insert the oil seal into the assembly by using SER / 307.
18. Insert the 'O' ring into the pinion assembly.
19. Insert the end flange into the pinion assembly.

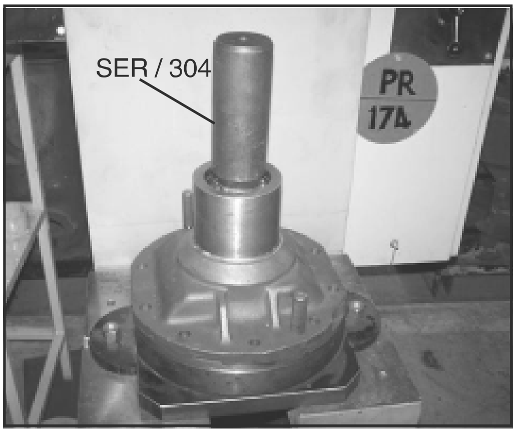


Fig 62

20. Install the washer and castle nut and tighten to a torque of 66 lbf.ft. (90 Nm).
21. Ensure the castle nut slot matches with the hole in the pinion shaft. If needed tighten the castle nut up to 73 lbf.ft (100 Nm). Secure the nut with spilt pin.

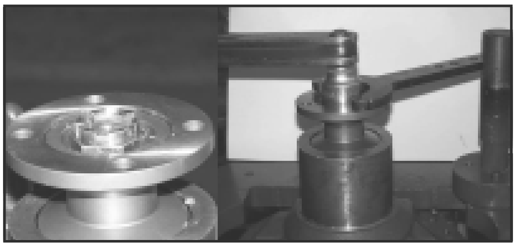


Fig 63

7B- 16 STEERING RAM

Removal and refitment

Removal

1. Remove the front axle assembly, see operation 7B - 5.
2. Remove the nyloc nut and discard, disconnect both steering ball joints.
3. Holding the ends of the steering ram piston rod with a spanner unscrew both track rods.
4. Remove the four hexagon cap screws (8 mm hexagon wrench will be required) and the steering ram.

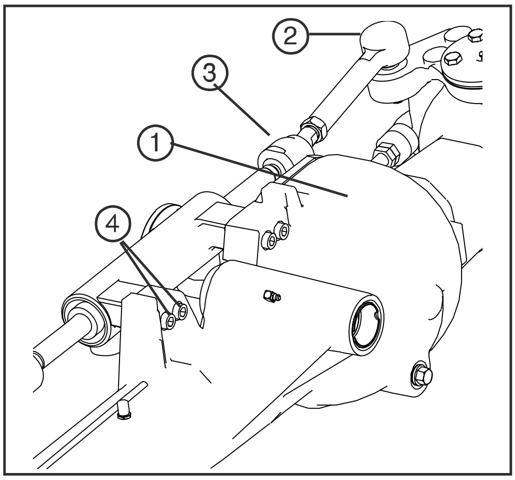


Fig 64

Refitment

5. Reverse procedure except:

   a. Apply Massey Ferguson stud lock (Loctite 118) to the threads and tighten the four cap screws to a torque of 81 - 88 lbf.ft (110 - 120 Nm).

   b. Tighten the steering rod ball joints to a torque of 169 - 184 lbf.ft (230 - 250 Nm).

   c. Apply loctite 118 to the thread and tighten the ball joint nut to a torque of 114 - 125 lbf.ft (155 - 170 Nm).

   d. Check the wheel alignment, see operation 7B - 3.

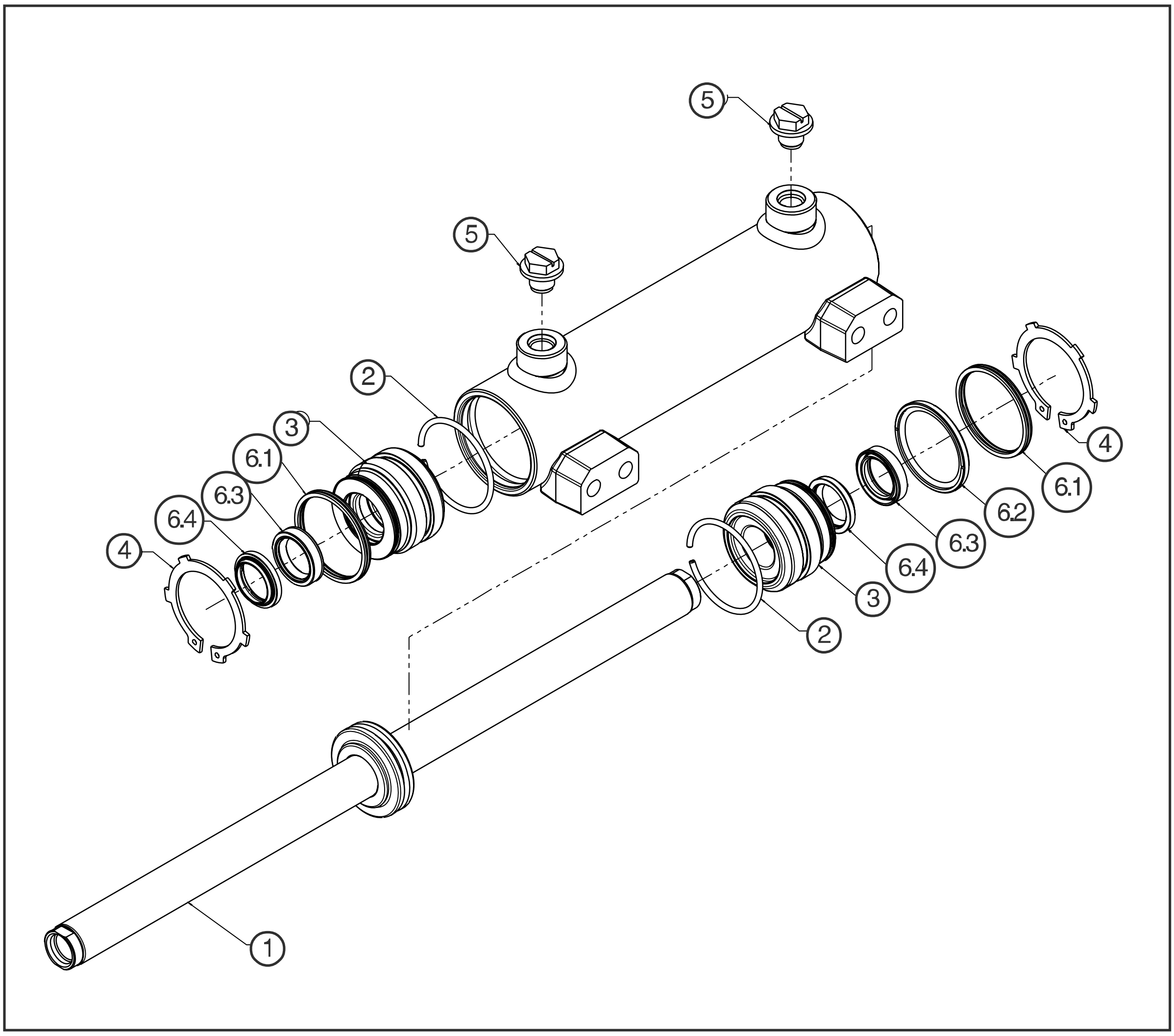

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Fig 64 a (Steering cylinder exploded view)

1.	Assembled rod
2.	Retaining ring
3.	Head
4.	Seeger ring
5.	Cap
6.1	Static seal
6.2	‘O’ ring
6.3	Rod wiper seal
6.4	Rod seal

7B - 17 Steering cylinder

Overhauling (OGNIBENE MAKE)

Special tools:

SER / 352 - Cylinder gland assembly tool.

SER / 353 - Rod mounting bell

SER / 354 - Rod seal mounting bell.

SER / 355 - Piston seal pusher tool.

SER / 356 - Piston seal calibration tool.

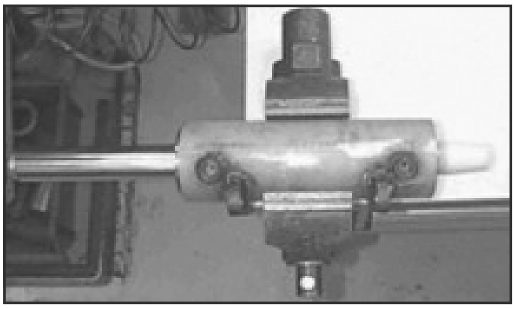

Fig 65

Removal

1. Fix the cylinder in the vice with aluminum jaws or such aluminum protection on jaws.
2. Keep the rod at the end of stroke, you will work on one side first and on other side after that.
3. Fix the body taking care to avoid scratches on the surface.
4. Remove the external seeger with the piler at the first side of operation.

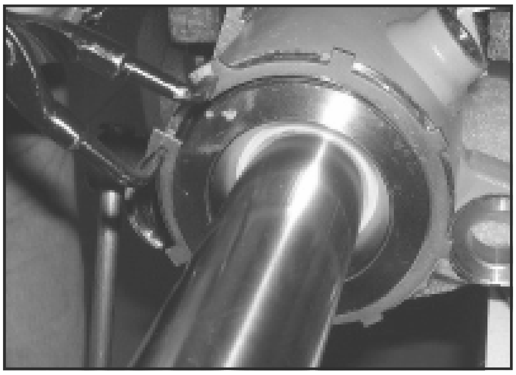

Fig 66

5. Keep the gland assembly tool SER / 352 on the first gland.
6. Use the plastic hammer to tap the gland assembly tool and push the gland inside the housing for approx 20/30 mm.

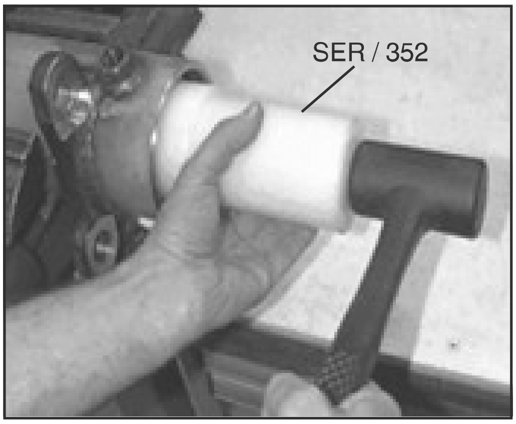

Fig 67

7. Use the flat screw driver straight to remove the internal snap ring from the housing.

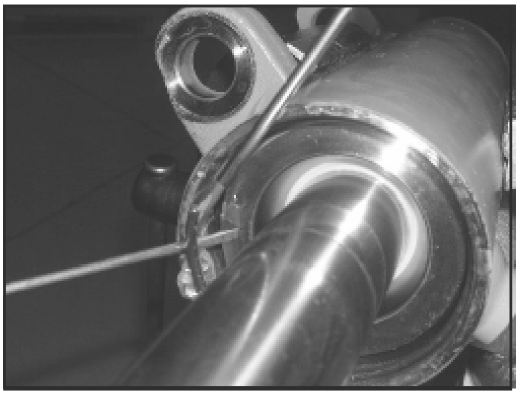

Fig 68

8. Take the rod tool and screw it on the rod.
9. Push the rod with the hammer from the side and let the first gland come out from the other side.

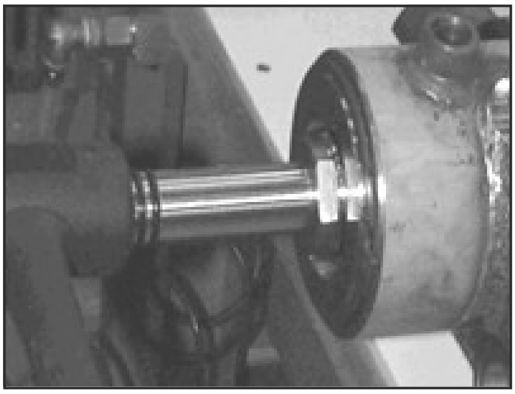

Fig 69

10. Remove the rod (pull it). Have no fear of damaging seals and guide rings, because they shall be replaced any how.

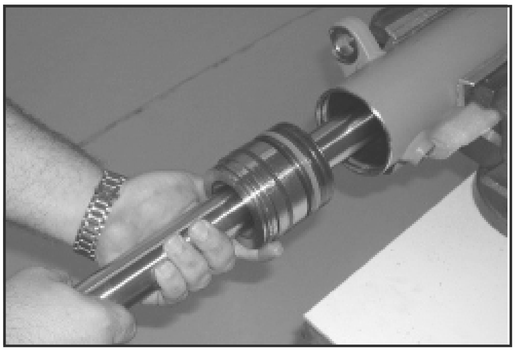

Fig 70

11. Use the pilers to remove the external seeger at the other side of body.

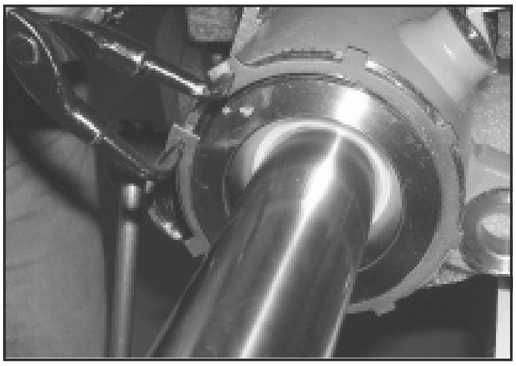

Fig 71

12. Mate the gland assembly tool SER / 352 on the gland. Use the plastic hammer to tap the gland and drive it inside the body for 20 / 30 mm.

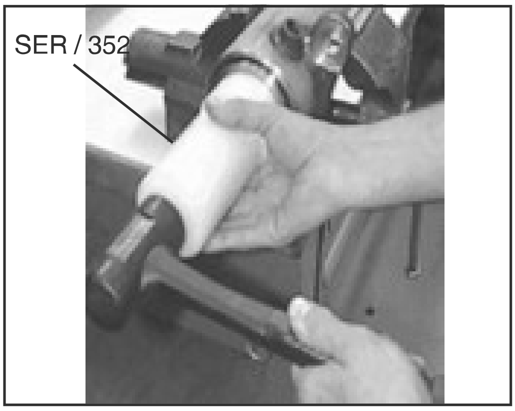

Fig 72

13. Use the flat screw driver straight to remove the internal snap ring from the housing.

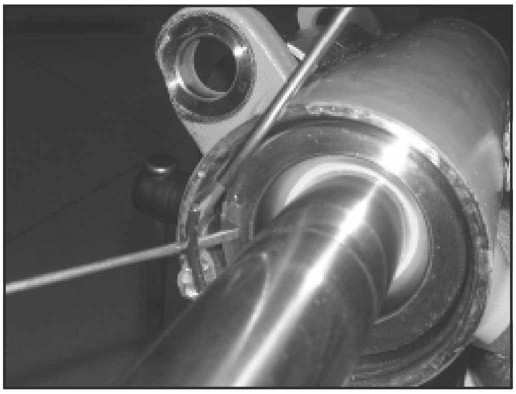

Fig 73

14. The piston and the two glands disassembled from the cylinder shall be separately resealed. Use the screw drive to remove the seal and the ‘O’ ring from the piston.

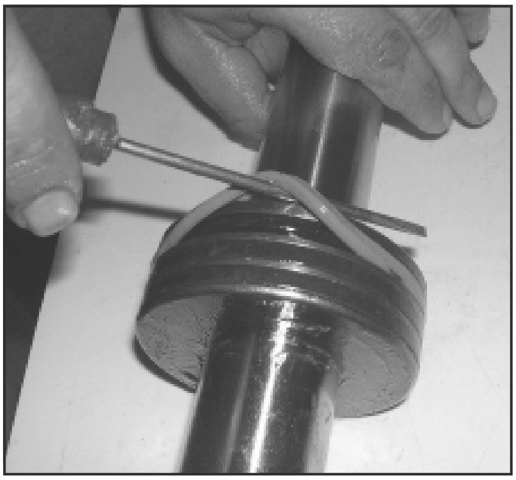

Fig 74

Seal replacement

15. Scrap used seal and open the seal kit. Clean the piston. Apply piston seal mounting bell SER / 354 next to the piston and insert the ‘O’ ring, having it slipping on the bell.

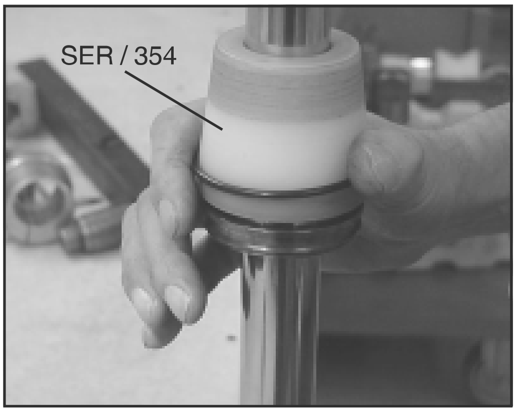

Fig 75

16. Insert the external ring of the piston seal over the 'O' ring mounted. Position the pushing tool SER / 355 over the bell, take the pushing tool and overlap the piston with it. The seal will fits its groove automatically.

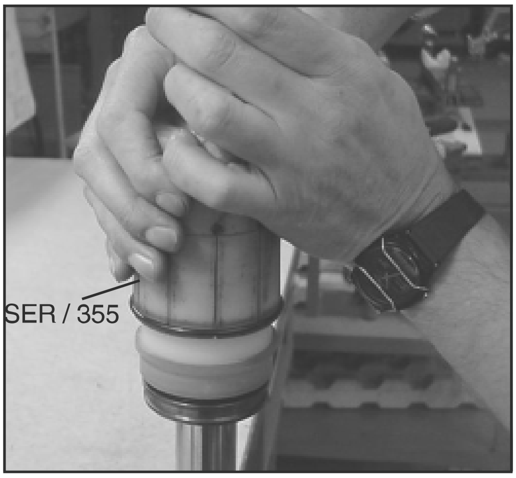

Fig 76

17. Resize the seal with the calibration tool SER / 356.

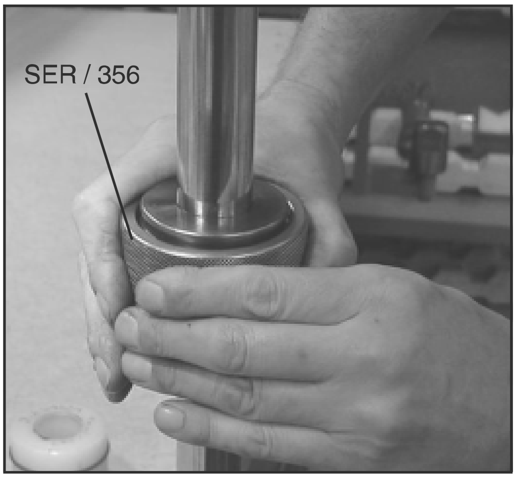

Fig 77

18. Remove the seals from the gland with the screw driver. Use the screw driver with care avoid any scratch on seal grooves.

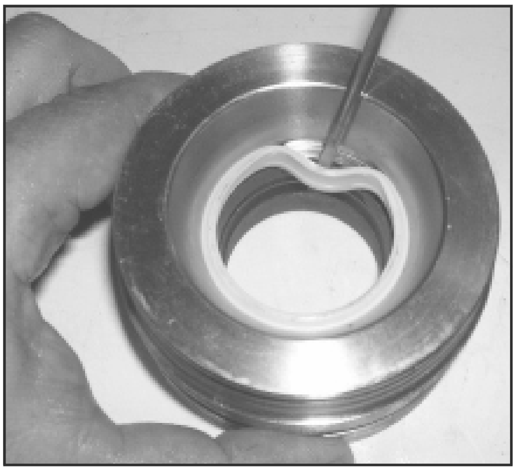

Fig 78

19. Remove the rod seal with the screw driver. Be sure to avoid scratches of the grooves.

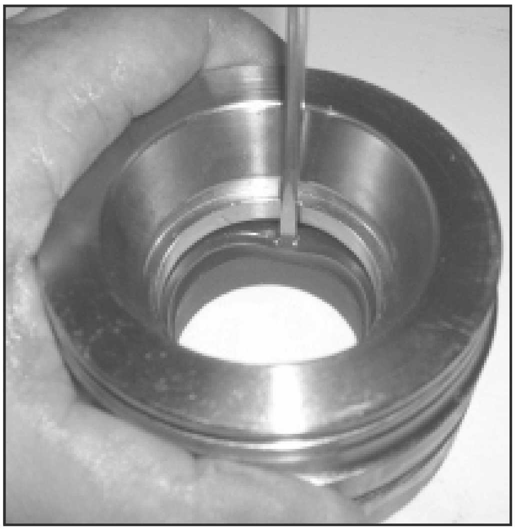

Fig 79

20. Remove the external static seal paying attention not to scratch the groove surface.

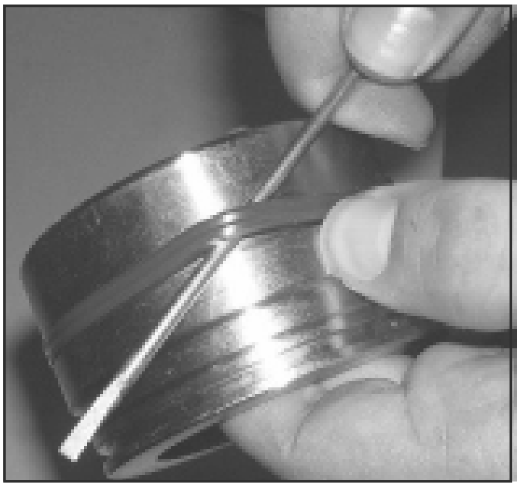

Fig 80

21. Carefully wash the glands and check if any gross material is left, before assembly of new seals , residual materials could damage the inner surfaces of the cylinder.

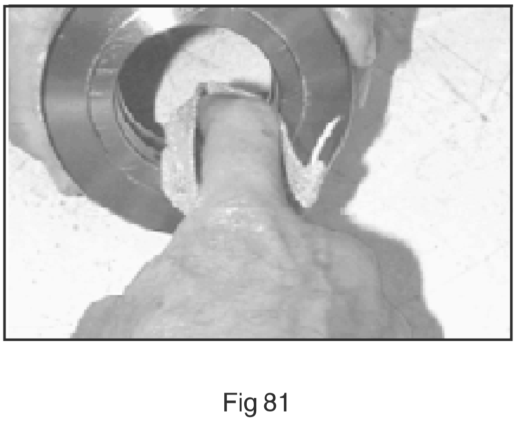

Fig 81

22. Assemble the rod seal.

    Note : *Mind the orientation of the lips. The seal lips shall be orientated to the oil pressure (Inner side of the cylinder).*

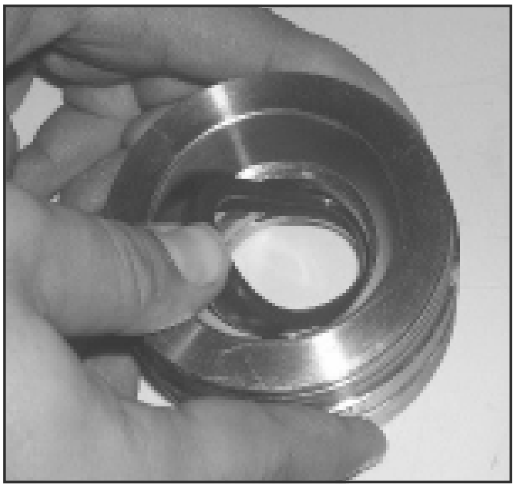

Fig 82

23. Use the screw driver to let the rod seal fit into the its groove. Avoid to make damage on rod seal.

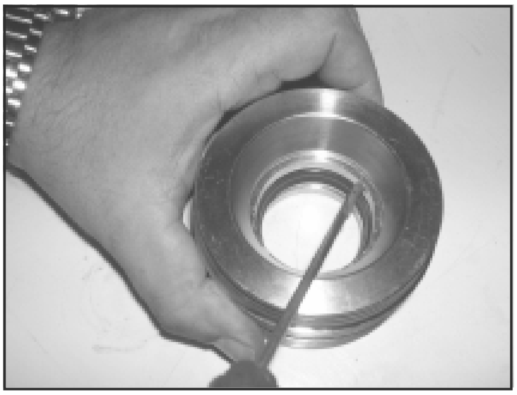

Fig 83

24. Assemble the rod wiper manually.

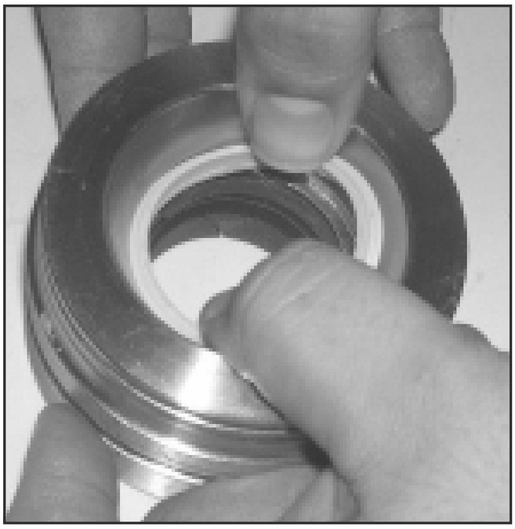

Fig 84

25. Manually assemble the static seal over the glands.

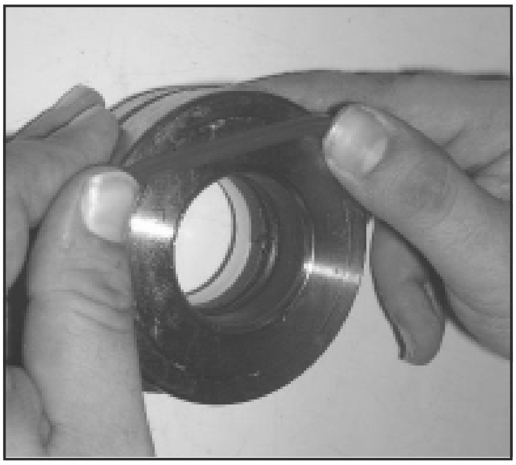

Fig 85

Reassembly

26. Place one of the glands at one side of the housing, put a plastic bell next to it and hammer to make it enter by about 20/30 mm in to the tube.

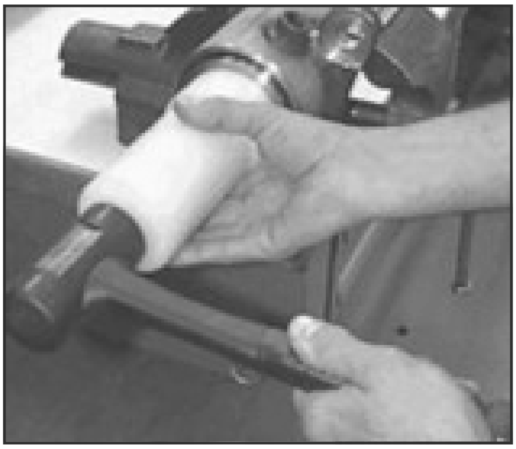

Fig 86

27. Manually insert the snap ring into the cavity.

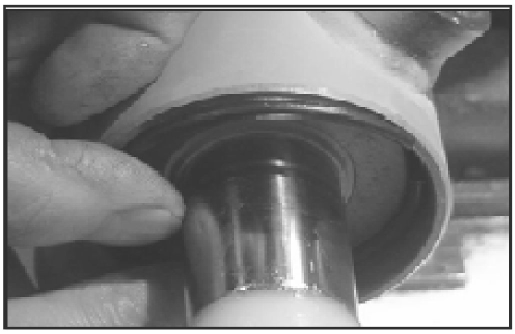

Fig 87

28. Screw the bell SER / 353 on the rod and slide it into the housing. Keep on sliding the piston / rod assembly, until it reaches the gland already assembled on the opposite side.

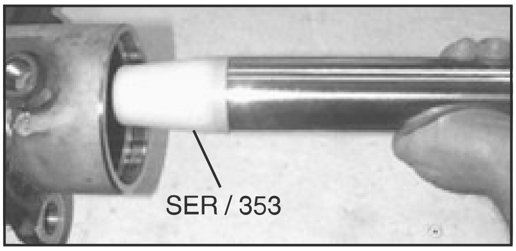

Fig 88

29. Use the hammer to completely push the piston / rod assembly inside the body , until it comes to a stop when piston hits the gland assemble yet. Be careful not to damage the piston seal.

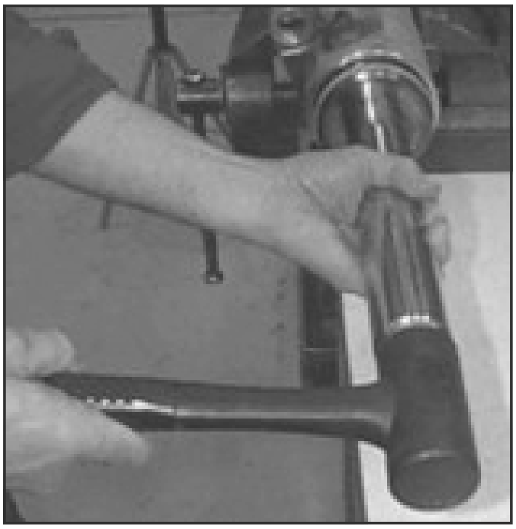

Fig 89

30. Unscrew the bell SER / 353 and screw it at the opposite side of the rod.

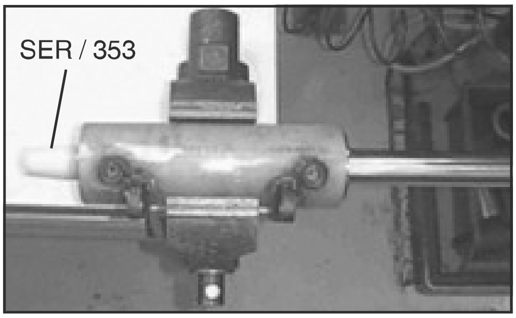

Fig 90

31. Manually insert the second gland in the body.

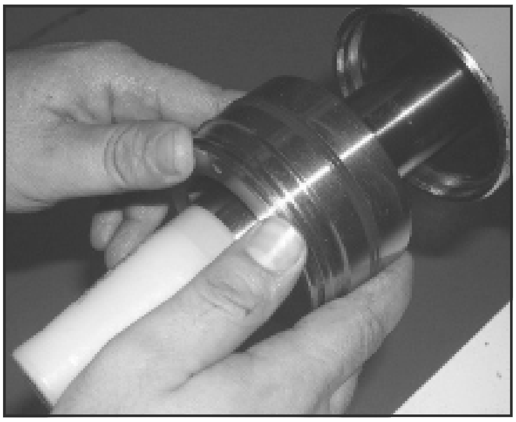

Fig 91

32. Use the hammer and the bell to push the gland inside the body by about 20/30 mm.

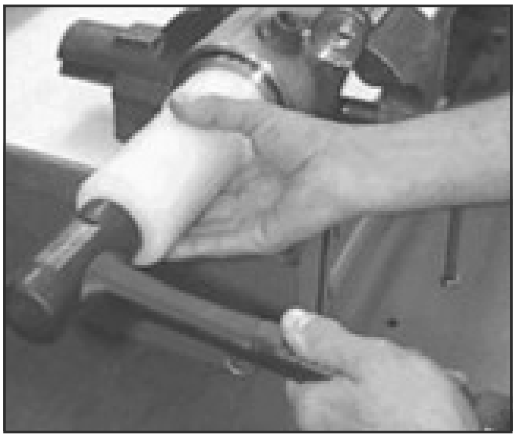

Fig 92

33. Place the snap ring on the gland.

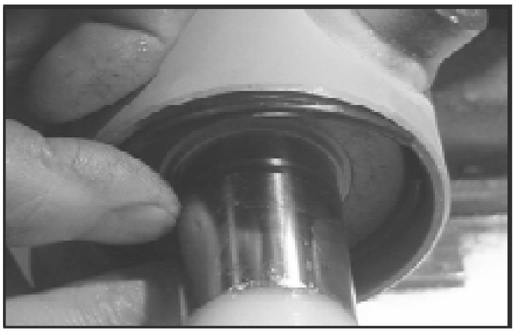

Fig 93

34. Use the pliers to assemble the seeger ring on the first gland. Use the hammer to completely push the piston/rod assembly inside the body, until it comes to a stop when piston hits the opposite gland.

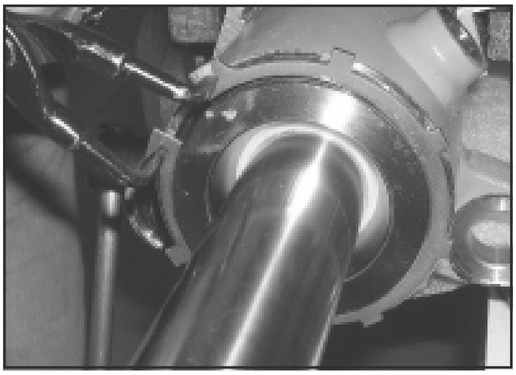

Fig 94

35. Assemble the seeger on the second gland. Now the cylinder is ready for usage

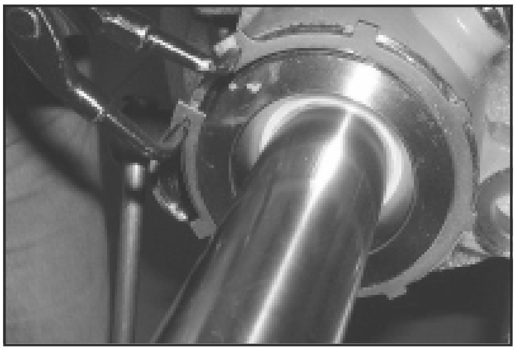

Fig 95

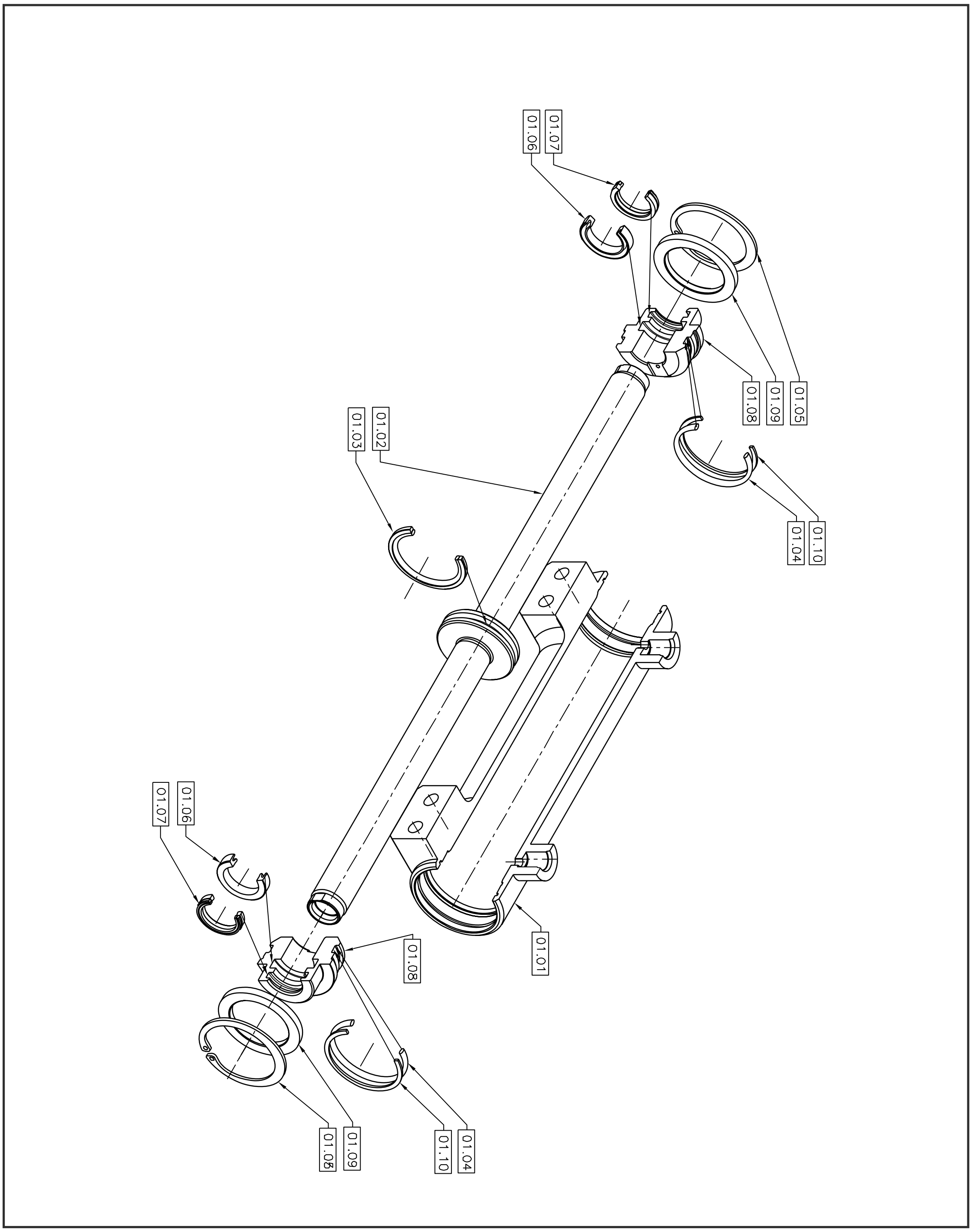
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Fig 96 (Steering Cylinder exploded view)

01.01	Cylinder body	01.06	Rod seal
01.02	Piston rod	01.07	Wiper
01.03	Piston seal	01.08	End cover
01.04	O ring	01.09	Metal ring
01.05	Internal circlip	01.10	Back up ring

7B - 18 Steering cylinder.

Overhaul (Poly hydron Make)

Special Tools:

SER 357 - Piston seal pusher

SER 358 - Piston seal loader

SER 359 - Piston seal resizer

Dis-assembly

1. Remove the steering ram from the tractor.
2. Remove any sealing plugs and drain out any oil in the ram cylinder by moving the piston from one end of the cylinder to the other. Hold the cylinder over a container during this operation.
3. Hold the ram cylinder in a table vice as shown in the fig 97.
4. Remove the circlip by using the standard circlip plier at both ends from the cylinder body.
5. Withdraw the piston assembly from the cylinder body with either left or right end cover.
6. Remove the other end cover.

Examination

Clean and inspect all parts, renew any that are worn or damaged. Renew all seals, wear rings and 'O' rings.

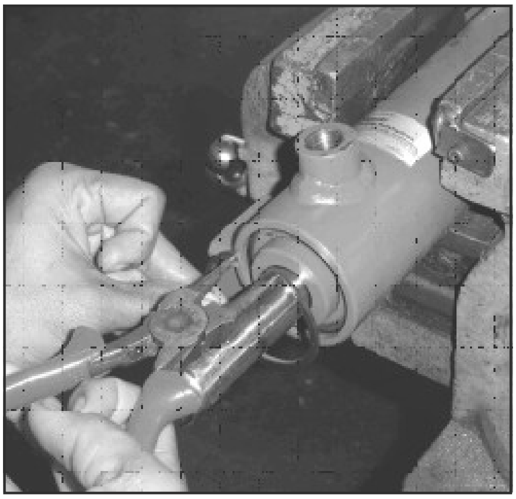

Fig 97

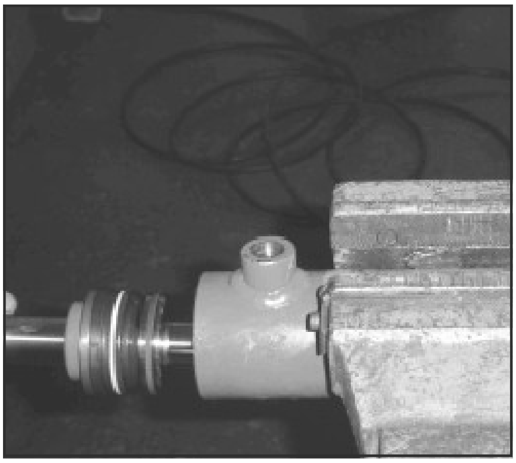

Fig 98

SEAL REPLACEMENT PROCEDURE:

7. Cut the piston seal and remove .

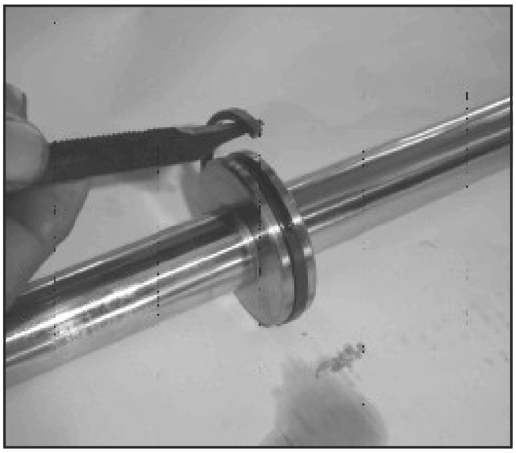

Fig 99

8. Remove the elastomer ring.

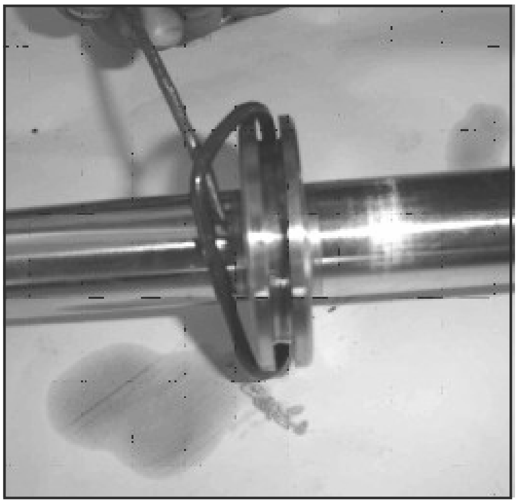

Fig 100

9. Remove the wiper seal.

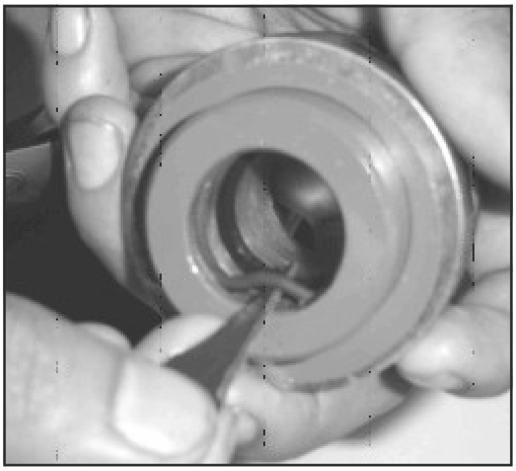

Fig 101

10. Remove the rod seal .

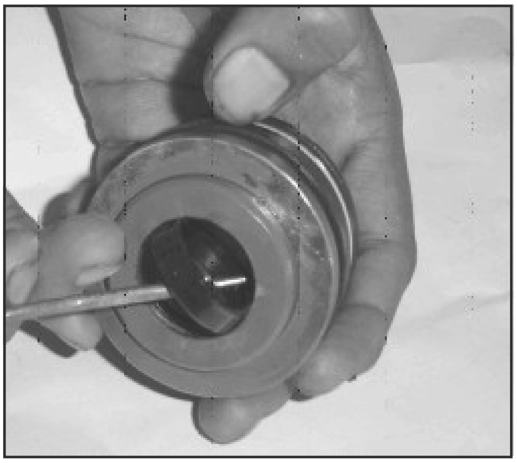

Fig 102

11. Remove the back up ring and ‘O’ ring.

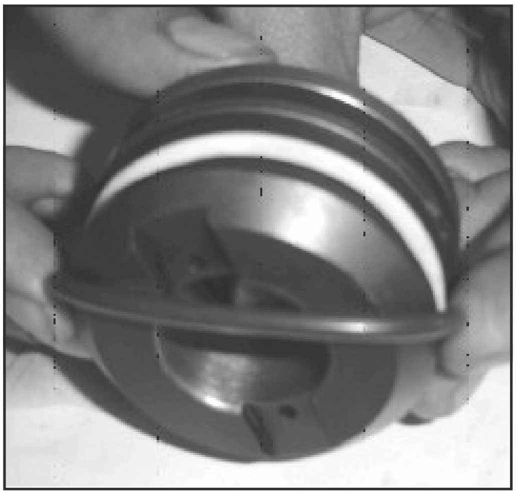

Fig 103

Replacement:

12. Fit a new set of rod seals in Both the end covers.

NOTE: Grooved face of rod seal always facing towards the piston seal side.

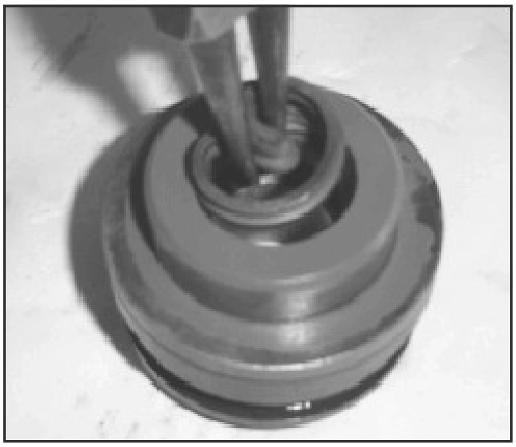

Fig 104

13. Fit a new set of back up ring and ‘O’ ring in Both the end covers.

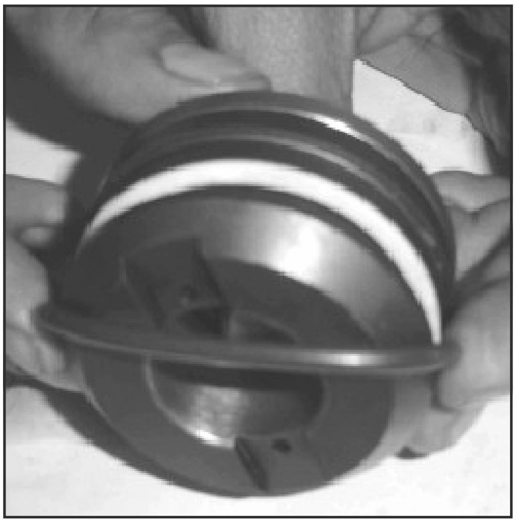

Fig 105

14. Renew the elastomer ring on the piston and lubricate.

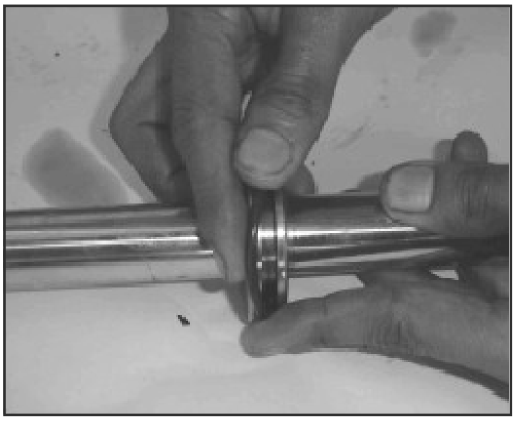

Fig 106

15. Expand piston seal by using SER / 357 pusher and SER / 358 loader

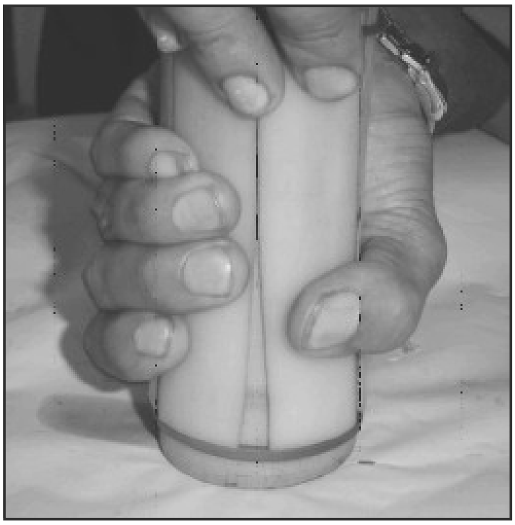

Fig 107

16. Renew the piston seal on the piston and lubricate

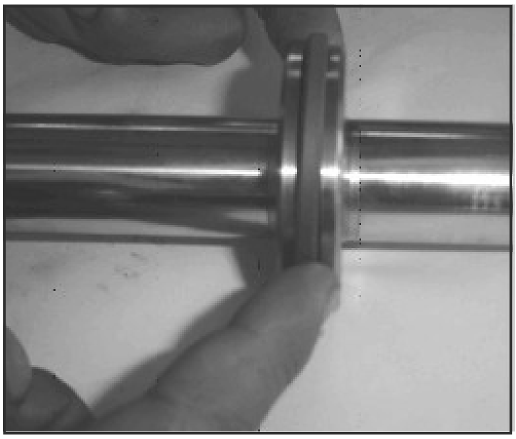

Fig 108

17. Insert the piston with seal into the SER / 359 piston seal resizer to resize the piston seal.

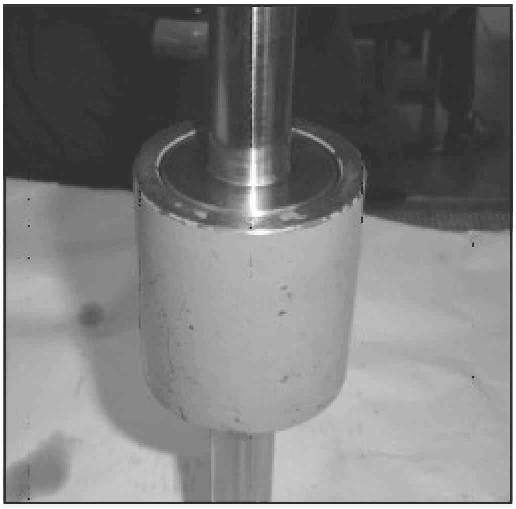

Fig 109

18. Insert a end cover into the piston rod and insert the assembly into the cylinder body.

ASSEMBLY:

19. Refit the end cover.
20. Refit the circlip
21. Refit the steering ram to the tractor.

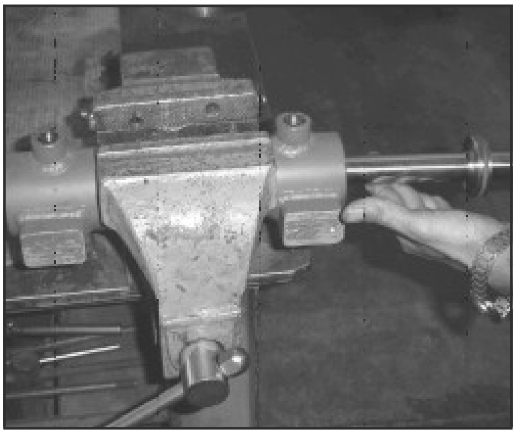

Fig 110

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Section 7

Part C

Front Axle - 4 Wheel Drive
(Dana Make)

Front Axle - 4 Wheel Drive
(Dana Make)

Section 7 - Part C

Table of Contents

Operation No.	Description	Page No.
———	Specification..	7C - 3
———	General description...	7C - 4
7C.1	Wheel alignment and steering stops - adjust....................................	7C - 5
7C.2	Track rod and ball joint - removal...	7C - 5
7C.3	Front axle - removal...	7C - 6
7C.4	Planetary carrier - removal...	7C - 7
7C.5	Hub oil seal- removal..	7C - 8
7C.6	Planetary carrier and hub - overhaul...	7C - 12
7C.7	Swivel housing and pins - removal...	7C - 14
7C.8	Drive shaft and oil seals - removal..	7C - 16
7C.9	Drive shaft - overhaul...	7C - 17
7C.10	Pinion oil seal - removal...	7C - 18
7C.11	Differential assembly - removal...	7C - 20
7C.12	Differential assembly - overhaul...	7C - 20
7C.13	Crownwheel and pinion - overhaul..	7C - 23
7C.14	Steering ram - removal...	7C - 26
7C.15	Steering ram - overhaul..	7C - 27

Specification - Front Axle

Axle type - MF2625 tractors	AG 65 SDN - Standard (no diff lock)
Camber angle	1°
Toe-in	0 - 0.196 inch (0 - 5mm)
Axle reduction ratio	2.7692:1
Crownwheel and pinion	13 x 36 teeth
Pinion setting dimension	3.582 inch (91mm)
Pinion bearing pre-load	17.701 lbf.inch (2Nm)
Crownwheel and pinion backlash	0.0051 - 0.007 inch (0.13-0.18mm)
Differential bearing pre-load	With zero end-float tighten bearing nut three notches.
Epicyclic reduction ratio	4.1538:1
Swivel pin pre-load	0.006 - 0.0098 inch (0.15 - 0.25mm)

Oil capacity:

Hub	0.052 gal (0.20 liter) each side
Axle	0.990 gal (3.75 liter)

Special tools

MF.195C	Bearing remover/replacer
MF.451B	Axle swivel pin remover
MF.480	Pinion nut wrench
MF.481	Hub nut wrench
MF.482	Steering ram wrench
MF.488	Four-wheel drive hub puller
MF.493	Hub seal installer
MF.495	Planetary ring gear replacer
MF.496	Wear ring installer
FT.4062A	Pinion pre-load gauge

Bolt torques

Track rod locknuts	83 lbf.ft (112 Nm)
Ball joint nuts	78 lbf.ft (106 Nm)
Wheel nuts	199 lbf.ft (270 Nm)
Planetary carrier countersunk screws	35 lbf.ft (47 Nm)
Hub retaining nuts	313 lbf.ft (425 Nm)
Pivot pin cap bolts	52 lbf.ft (70 Nm)
Pinion nut	218 lbf.ft (295 Nm)
Differential case bolts	52 lbf.ft (70 Nm)
Crownwheel bolts	112 Nm (83 Nm)
Differential bearing cap bolts	105 lbf.ft (143 Nm)
Steering ram cap screws	79 lbf.ft (107 Nm)

GENERAL DESCRIPTION - FRONT AXLE

The Massey Ferguson four wheel drive front axle is driven by a drive shaft along the left-hand side of the tractor from a transfer gearbox bolted to the side of the rear center housing. The transfer gearbox contains the reduction gears and clutch to control the engagement and disengagement of the front axle.

The front axle has the crownwheel and pinion and differential mounted on the left-hand side of the axle to align with the drive shaft making it a side-drive arrangement.

The drive is taken through a standard crownwheel and pinion and differential arrangement. The crownwheel is mounted on the left-hand side of the differential. The differential contains a cross with four differential bevel gears, these mesh with two side bevel gears to which the inner ends of the drive shafts splined.

The drive shafts transmit the power through double universal joints at the steering pivot to the epicyclic reduction units in the front wheels. The front axle is attached to the front support casting by means of a center pivot pin in a similar manner to the two wheel drive axle.

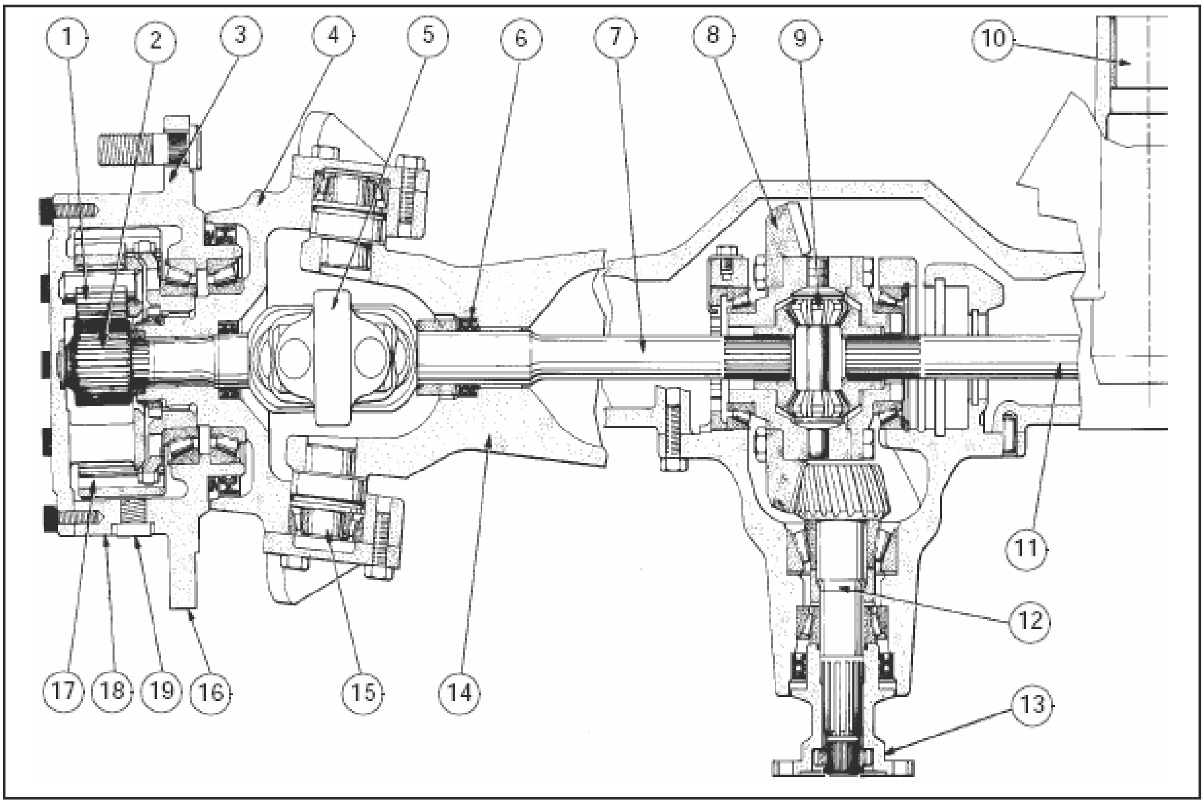

Fig 1

1. Planetary gears.
2. Sun gear.
3. Wheel studs.
4. Pivot housing.
5. Universal joint.
6. Oil seal.
7. Drive shaft.
8. Crownwheel.
9. Differential unit.
10. Axle pivot housing.
11. Drive shaft.
12. Pinion.
13. Drive coupling.
14. Axle housing.
15. Pivot pin.
16. Wheel hub.
17. Ring gear.
18. Planetary carrier.
19. Oil filler/drain plug.

7C.1 WHEEL ALIGNMENT AND STEERING STOPS

Adjust

Procedure Wheel alignment

1. Drive the tractor onto firm level ground and put the front wheels in the straight ahead position.
2. Check the wheel toe-in measured on the centre line of the axle at the wheel rim. Distance 'A' must be 0 - 0.196 inch (0- 5mm) greater than distance 'B'.
3. If adjustment is necessary, slacken the locknut on the track rods on one side.
4. Rotate the inner steering ball joint to either increase or decrease the track rod length to obtain the correct setting.
5. Tighten the track rod locknut to a torque of 83 lbf.ft (112Nm). Ensure that both track rods are the same length. Steering stops
6. The steering stop adjustment is made according to the maximum steering angle required.
7. Adjust the length of the bolt according to the table below and tighten the locknut.

   Steering angle Dimension 'X'

   35° . . . . 3.051 inch (77.5 mm)

   40° . . . . 2.6378 inch (67.0 mm)

   50° . . . . 1.7126 inch (43.5 mm)

CAUTION: The normal setting is 50 ° . Ensure that the tire does not foul the tractor when on full lock and full axle tilt.

7C.2 TRACK ROD AND BALL JOINT

Removal and refitment

Removal

1. Remove the split pin and nut from the ball joint.
2. Remove the ball joint from the housing by using an extractor or by striking the housing with a hammer adjacent to the ball joint to release the taper.
3. Slacken the locknut and unscrew the ball joint from the track rod.
4. To remove the inner joint, hold the end of the steering ram piston rod with a spanner and unscrew the joint.

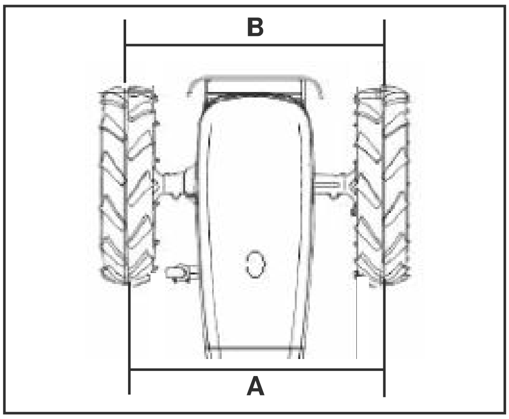

Fig 2

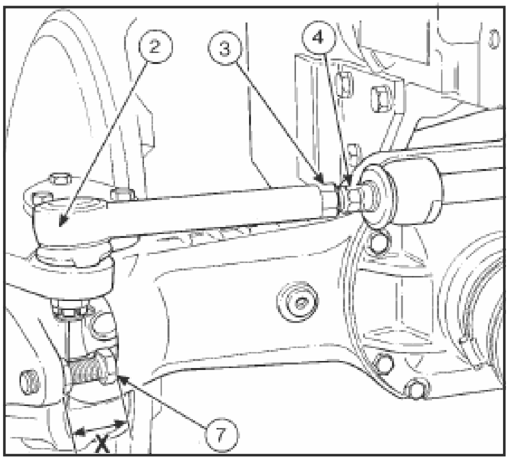

Fig 3

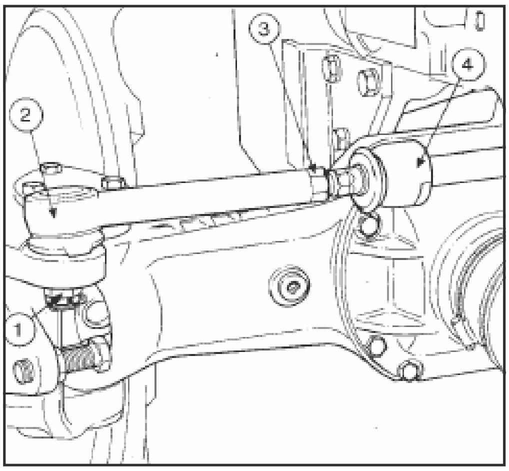

Fig 4

Refitment

5. Reverse procedure 1 to 4 except:

   a. Ensure that both track rods are the same length.

   b. Apply Massey Ferguson Stud Lock (Loctite 270) to the threads of inner joint and screw it into the end of the steering ram piston rod.

   c. Set the wheel alignment as described in operation 7C.1.

   d. Tighten the track rod lock nut to a torque of 83 lbf.ft (112Nm).

   e. Apply lubricating oil to the thread and tighten the ball joint nut to a torque of 78 lbf.ft (106Nm). Then tighten further as required to align the nut for the split pin. Renew the split pin.

7C.3 FRONT AXLE

Removal and refitment

Removal

1. Place a trolley jack under the engine sump and take the weight of the front of the tractor. DO NOT lift the front wheels off the ground.
2. Remove the front weights, if fitted.
3. Remove the front weight frame.
4. Disconnect the steering ram hoses at the cylinder end.Cap the ends of the pipes and hoses to prevent the ingress of dirt.
5. Disconnect the front axle drive shaft, see operation 7C.8.
6. Remove the bolt securing the axle pivot pin to the front support casting.
7. Remove the axle pivot pin. If difficulty is experienced in removal, there is a 18mm tapped hole in the end of the pin for extraction purposes.
8. Jack up the front of the tractor so that the axle can be wheeled out from under the tractor.
9. Recover the two thrust washers located each side of the axle pivot.
10. Place the axle on two axle stands and remove the wheels.

Refitment

11. The axle pivot pin is fitted with a thrust washer at the front and back between the axle and the support casting. To fit the thrust washers when replacing the axle, obtain a piece of tubing or bar 47.6mm (1.875 inch) diameter and 25mm long. This is to hold the rear thrust washer in place during assembly.

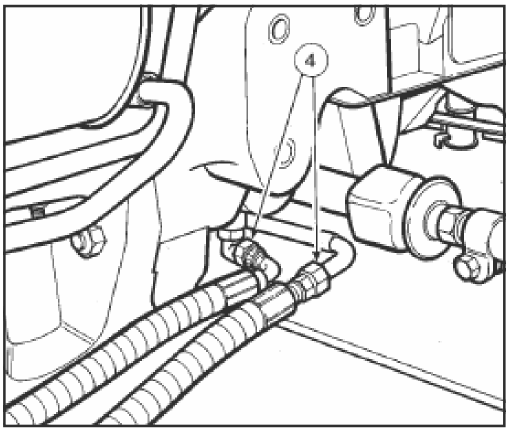

Fig 5

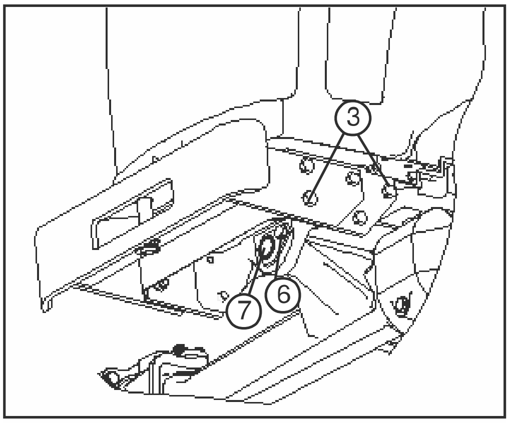

Fig 6

12. Place the tube or bar in the rear hole of the support casting so that it projects on the forward face. Coat one of the thrust washers with grease and place it on the tube or bar. Ensure that it is against the support casting face.
13. Lift the axle into position, pass the pivot pin through the front part of the support casting. Position the front thrust washer between the axle and casting. Continue to push the pin into the axle, through the rear thrust washer and into the casting at the rear. The pivot pin will push the piece of bar or tube out through the rear of the support casting.
14. Reverse procedures 1 to 10 except:

    a. On re-assembly grease the axle pivot pin.

    b. Check the steering to ensure that the hydraulic hoses have been correctly connected up turning the tractor to the left and right.

    c. Check that the steering hoses are correctly routed to prevent chaffing on sharp edges.

    d. Check the power steering pump oil level and remove the air from the system.

7C.4 PLANETARY CARRIER

Removal and refitment

Removal

1. Apply the parking brake and secure the rear wheels.
2. Raise the tractor under the side of the axle to be worked on, then support the axle on an axle stand.
3. Remove the wheel.
4. Rotate the hub until the plug is at the bottom. Remove the plug (8mm hexagon key will be required) and drain the oil from the hub.
5. Mark the position of the planetary carrier in relation to hub to assist alignment during refitment.

Later production hub

6. Remove the 12 bolts in the cover plate.
7. Remove the planetary cover plate.

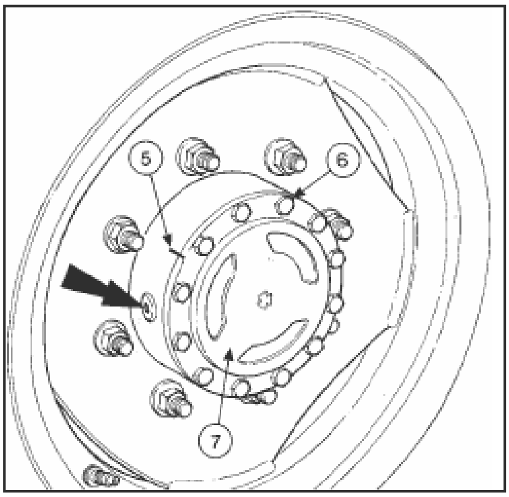

Fig 7

Refitment

8. Reverse procedures 1 to 7 except:

   a.Apply Massey Ferguson Instant Gasket (Loctite 515) to the hub face.

   b. Apply a light coating of lubricating oil to the planetary carrier countersunk screws (on early models) and tighten to a torque of 35 lbf.ft (47Nm).

   c.Apply a light coating of lubricating oil to the 12 planetary carrier bolts (on later models) and tighten to a torque of 106 lbf.ft (78Nm).

   d.Rotate the wheel so that the plug is at three O'clock. Fill the hub to this level with an approved oil and refit the plug.

   e. Tighten the wheel nuts to a torque of 199 lbf.ft (270Nm).

7C.5 HUB OIL SEAL

Removal and refitment

Special Tools:

MF.481	Hub nut wrench
MF.488	Hub Puller
MF.493	Hub seal installer
MF.495	Planetary ring gear replacer
MF.496	Wear ring installer

Removal

1. Remove the planetary carrier, see operation 7C.4.
2. Remove the circlip and sun gear.
3. With a narrow cold chisel and hammer carefully unstake the hub retaining nut where the lip has been driven down into the slot.
4. Using special tool MF.481 hub nut wrench, unscrew the retaining nut.
5. On later production tractors remove the planetary ring gear and hub with special tool MF.488 Hub Puller.
6. Place the cap over the end of the drive shaft. Bolt MF.488 across the face of the hub so that the forcing screw locates in the dimple in the cap. Adjust the length of the bolts so that they are all of equal length.

   IMPORTANT: *Lubricate all the threads of the forcing screw.*
7. Tighten the screw so that the hub and ring gear are drawn off the shaft.
8. Remove the wheel hub and ring gear from the tool.
9. Remove the dirt seal from the back of the hub.
10. With a cold chisel split the large oil seal and remove from the housing. Be careful not to damage the taper roller bearing.

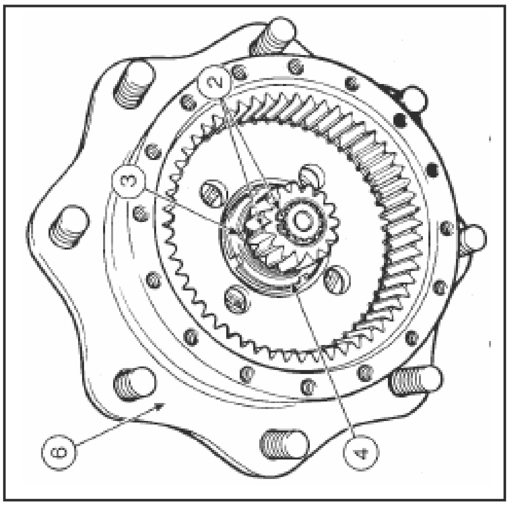

Fig 8

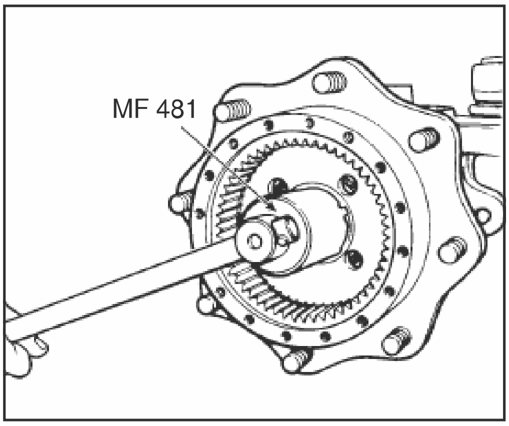

Fig 9

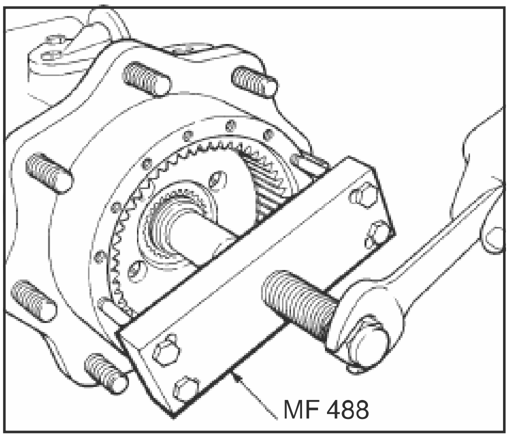

Fig 10

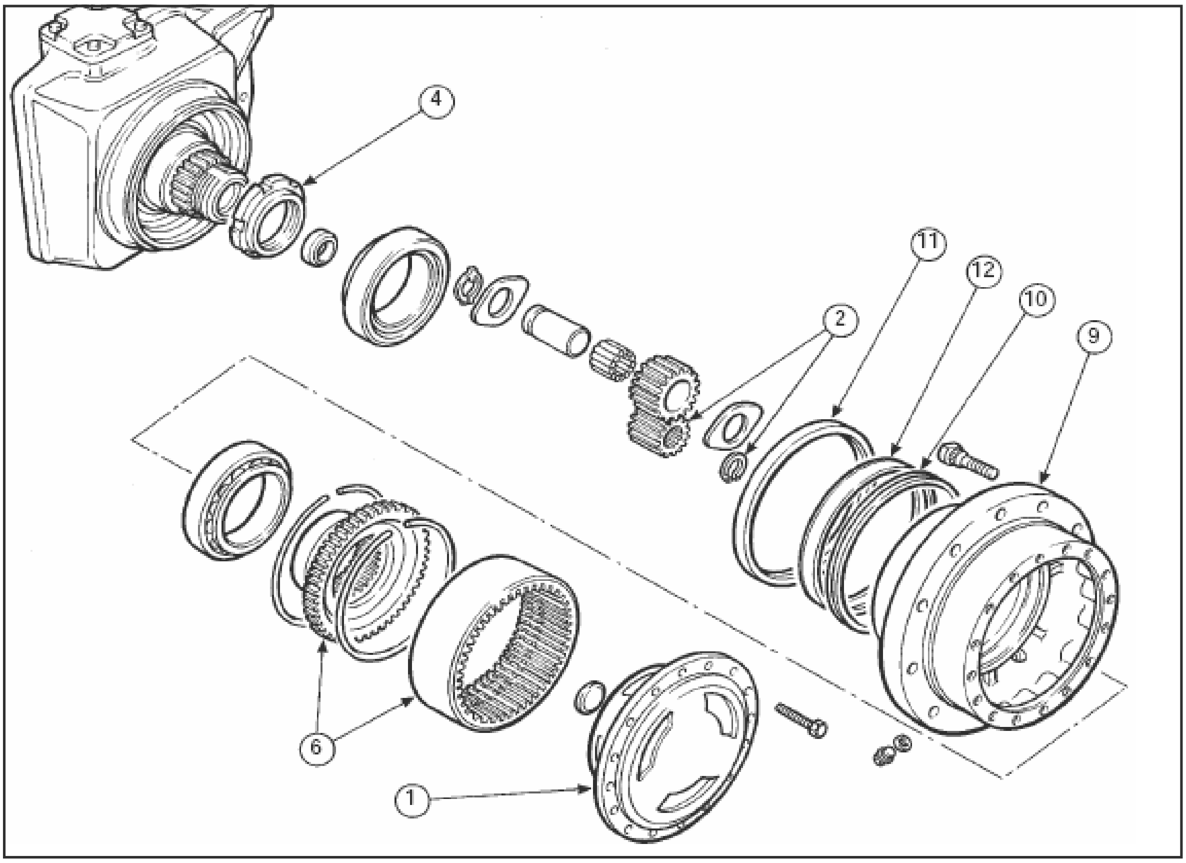

Fig 11

11. If necessary, remove the oil seal wear ring. With a cold chisel split the ring on the hub and remove.
12. Clean all components for re-assembly.

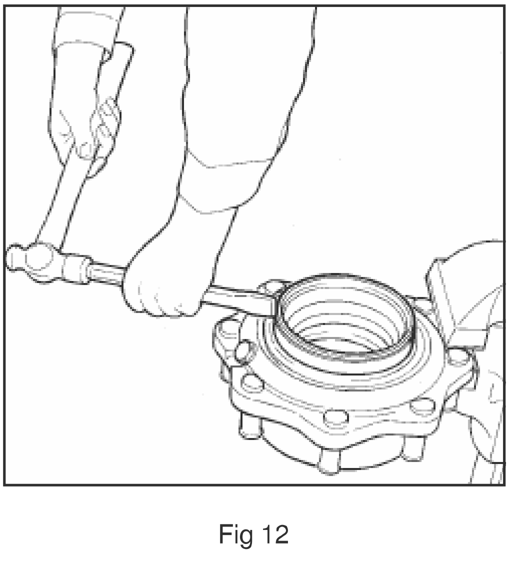

Fig 12

Refitment

13. Using special tool MF.493 Hub Seal Installer fit a new oil seal. Place the seal on the tool with the lip facing outwards.

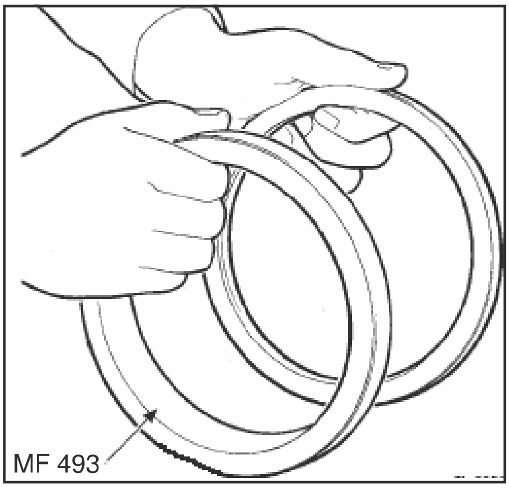

Fig 13

14. Offer the seal and tool assembly up to the swivel housing, with a hammer, gently drive the seal into the housing. Work around the seal driving in a small part at a time until it is fully home.

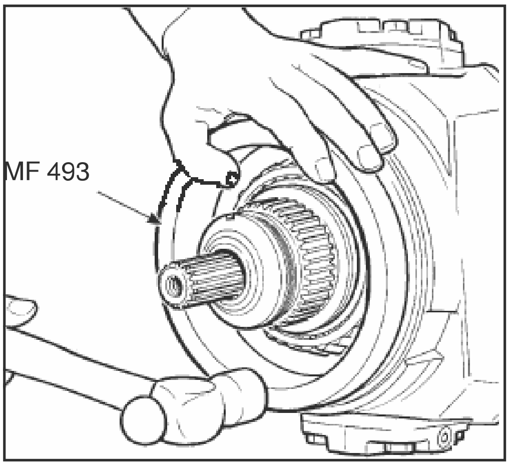

Fig 14

15. Fit the a new oil seal wear ring using special tool MF.496 Wear Ring Installer and a light hammer. Drive the wear ring down onto the hub using the same method when fitting the oil seal.

    NOTE: *The radius edge of the wear ring must face outwards.*

16. Renew the dirt lip seal on the back of the hub.
17. Fill the space between the dirt seal and the lip seal with general purpose grease. It must be 30 to 50% full. Also apply generous application grease to the lips of the seal.
18. Replace the hub.

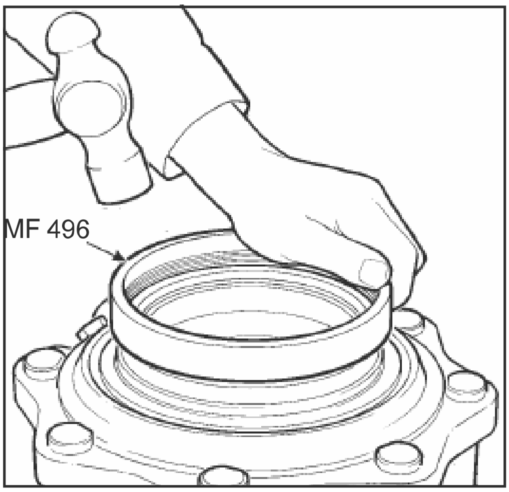

Fig 15

19. Replace the planetary ring gear carrier using special tool MF.495 Planetary Ring Gear Replacer.
20. To special tool MF.488 add the two extensions (part of MF.495) ensuring that the bolts are tight as shown in the illustration. It is important that they are fitted with the overlapping part to the outside.
21. Remove the top and bottom swivel pin caps and fit the two blocks complete with the threaded studs.
22. Suspend MF.488 on the studs and fit the nuts and washers.
23. Position the ring gear carrier so that the splines are in alignment. Place the cap over the end of the shaft and locate the forcing screw in the end of the cap.

    IMPORTANT: *Lubricate all the threads of the forcing screw.*

24. Tighten the screw until the carrier is pressed full home. DO NOT put excessive loads on the tool. Check by turning the hub to determine when the fitting has been completed.
25. Remove the special tool and replace the caps ensuring that the one with the shims is fitted on the top.
26. Renew the ring gear retaining nut and tighten to a torque of 313 lbf.ft (425 Nm) using special tool MF.481.
27. Hammer the lip of the nut down into the slot.
28. Replace the sun gear and circlip.
29. Replace the planetary carrier

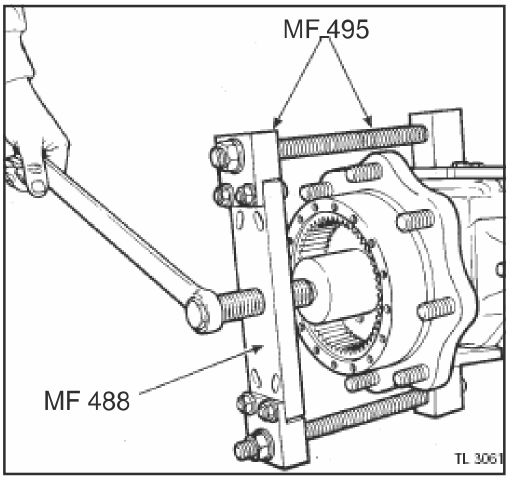

Fig 16

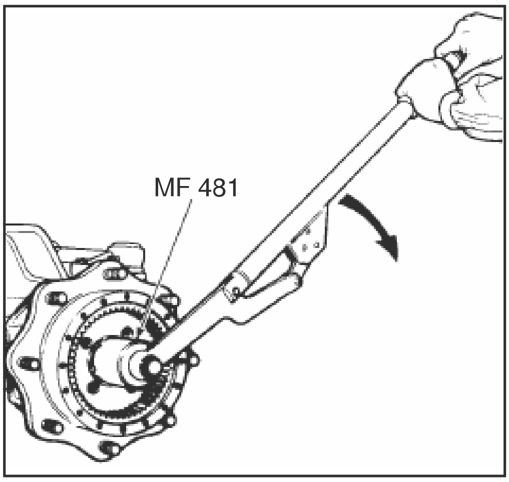

Fig 17

7C.6 PLANETARY CARRIER AND HUB

Overhaul

Dis-assembly

1. Remove the planetary carrier, see operation 7C.4.
2. Place the planetary carrier in a vice.
3. Remove the circlips.
4. Screw an 8mm bolt into the end of the shaft and withdraw the planetary gear shaft holding the gear in place.
5. Carefully remove the planetary gear and thrust washers taking care not to dislodge the needle roller bearings.
6. Remove the needle rollers and thrust washers by emptying them into a clean container.
7. Repeat procedures 3 to 6 for the remaining two planetary gears.
8. Remove the circlip and sun gear.
9. Dismantle the hub, see operation 7C.5.
10. If necessary, remove the two circlips and dismantle the ring gear.
11. If necessary, remove the two bearing cups.
12. Remove bearing cones. If this is necessary, the cage will have to be broken, and the rollers removed. To remove the inner track, heat it with a gas torch until it expands and can be removed with a pry bar.

    Examination: Thoroughly clean and inspect all components and renew any that are worn or damaged. Renew all ‘O’ rings and seals.

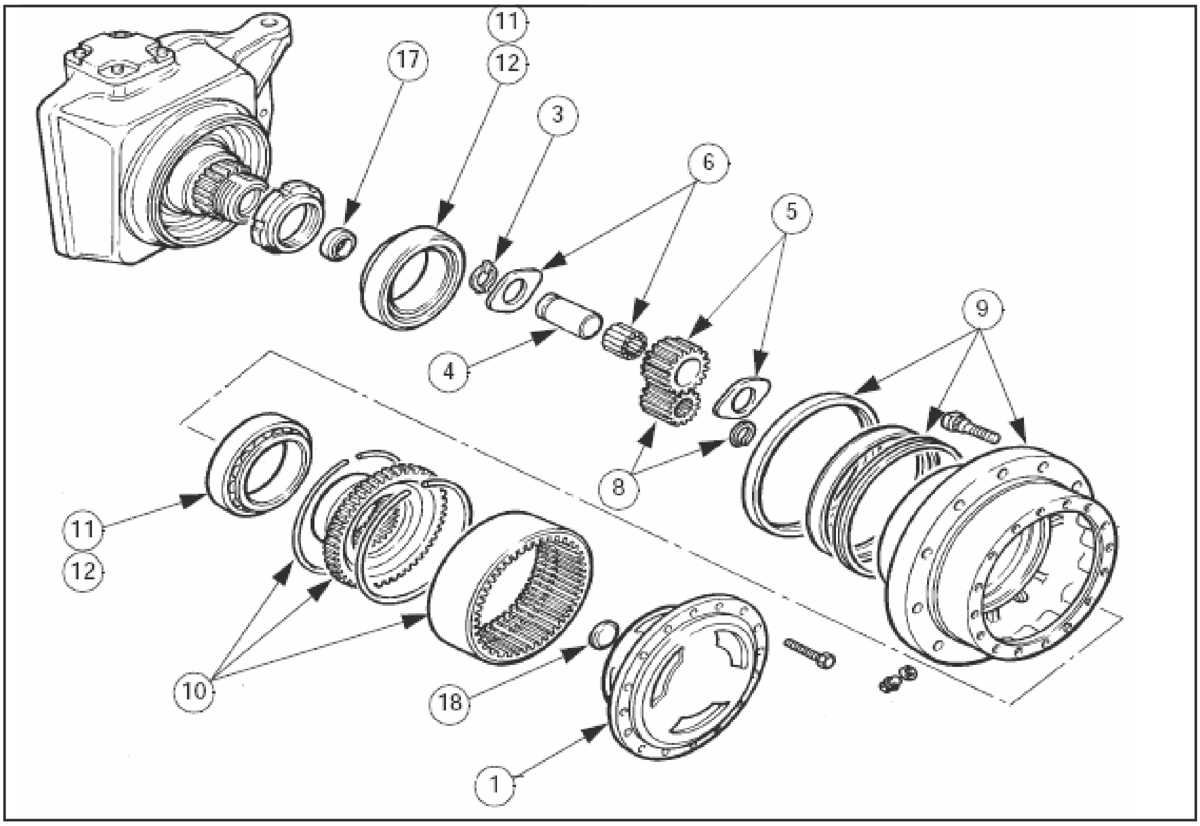

Fig 18

Re-assembly

13. Fit the inner taper roller bearing cone.
14. Fit the two taper roller bearing cups to the hub.
15. Fit the taper roller bearing cone to the planetary ring gear.
16. Re-assemble the ring gear fitting the two circlips and gear.
17. If the thrust ring has been removed it is retained in the housing with Massey Ferguson Stud Lock (Loctite 270).
18. If the drive shaft thrust pad has been removed it is retained in the cover with Massey Ferguson Stud Lock (Loctite 270).
19. Re-assemble the hub and seals, see operation 7C.5.
20. Refit the sun gear and circlip.
21. Refit the planetary carrier.
22. Re-assemble the planet gears. Use petroleum jelly, NOT grease, to hold the needle rollers and thrust washers in place during assembly. Each planetary gear contains 17 needle rollers.
23. Refit the gears to the planetary carrier using new circlips to hold the shafts in place.

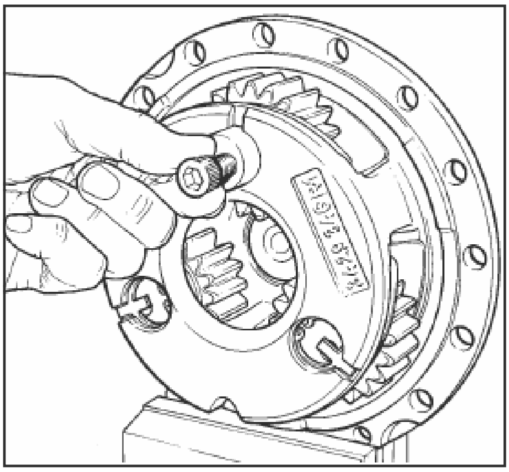

Fig 19

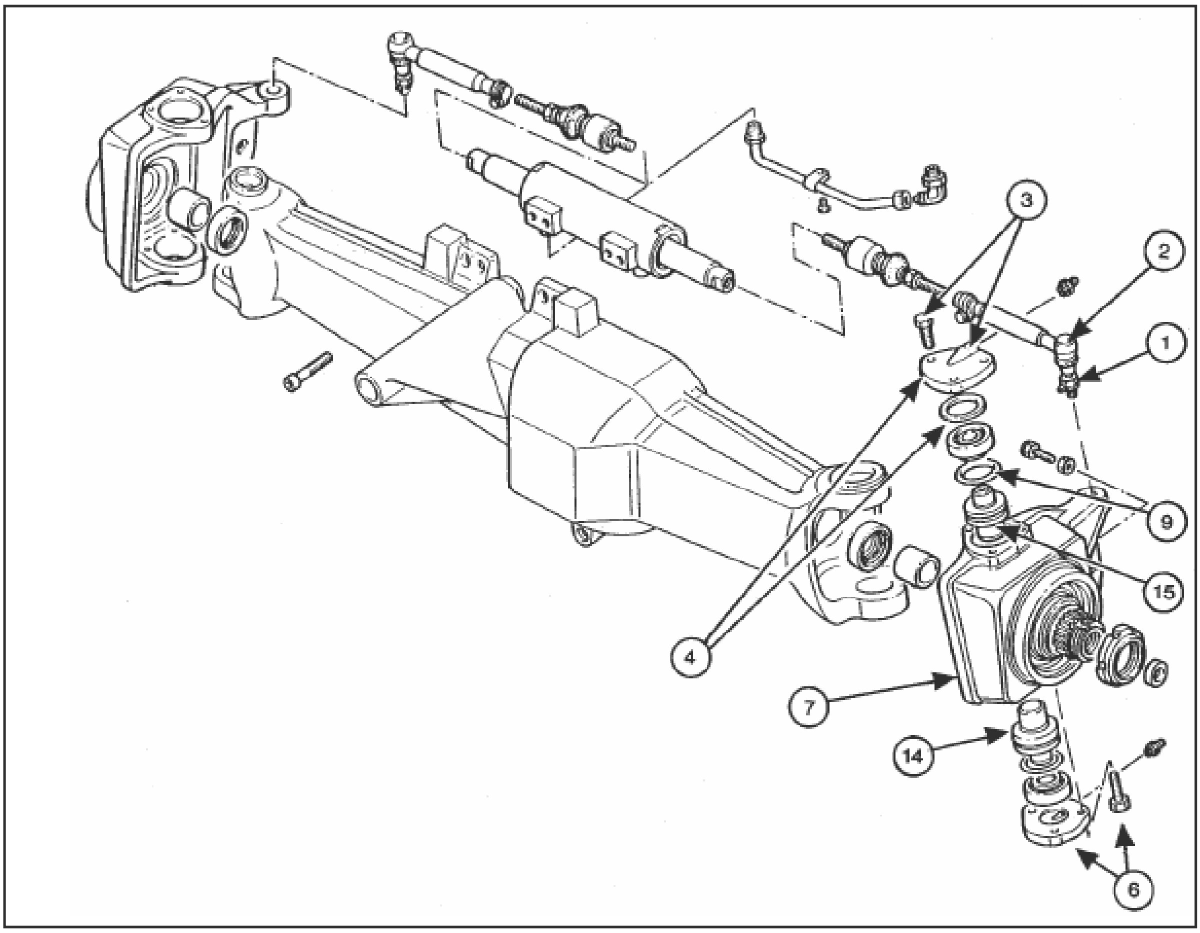

Fig 20

7C.7 SWIVEL HOUSING AND PINS

Removal and refitment

Special Tools:

MF.195C	Bearing puller - main tool
MF.451B	Steering pin bearing remover

Removal

1. Remove the split pin and steering ball joint nut.
2. Release the steering ball joint from the housing.
3. Remove the four bolts and the upper cap.
4. Remove the shims and bearing cup.
5. Using special tool MF.451B and MF.195C to extract the upper pivot pin. Screw the 14mm adaptor into the pin and onto the main puller. Remove the pin from the housing.

   IMPORTANT: *Lubricate all the threads of the forcing screw.*
6. Remove the four bolts and cap from the lower bearing and repeat the extraction of the pivot pin.
7. The housing can now be removed from the axle complete with the drive shaft.
8. This operation can now be repeated on the other side if the crownwheel and pinion assembly is to be removed.

   Examination: Thoroughly clean and inspect all components and renew any that are worn or damaged. Renew all ‘O’ rings and seals.

Refitment

9. Renew the seals on the pivot pins.
10. Fit the bearing cones to the pivot pins. DO NOT grease the bearings at this stage.
11. Coat the pivot pins and holes with a light application of grease.

12. Hold the housing in position and partly fit the upper pivot pin to locate the assembly.
13. Refit the lower pivot pin, bearing cup, cap and bolts. NO shims are fitted to the lower cap.
14. Tighten two opposing bolts evenly and in sequence to pull the lower pivot pin into the housing. Tighten the four bolts to a torque of 52 lbf.ft (70Nm).
15. Fit the upper bearing cup, shims, cap and bolts. Add additional shims to ensure that the pivot pins are seated on the axle casing. Tighten two opposing bolts evenly and in sequence to press the pivot pin into the housing.
16. Check that both pivot pins are fully seated onto the axle casing.
17. Remove the upper cap and shims.
18. Replace the cap and tighten the four bolts to torque of 52 lbf.ft (70Nm).
19. Using a dial indicator gauge and lever as shown in the illustration, determine the end-float of the two pivot bearings.

    When lifting the housing up and down with the lever ensure that you get the maximum reading on the dial indicator gauge. The correct bearing pre-load is 0.006 - 0.0098 inch (0.15 - 0.25 mm).
20. Select the required shims by the following method: Shims required = End-float + Pre-load Select shims from the following chart:

Part number	Thickness	
	mm	inch
3427 190 M1	0.1	0.004
3427 191 M1	0.15	0.006
3427 192 M1	0.3	0.012
3427 193 M1	0.5	0.020
3427 194 M1	0.7	0.028
3427 195 M1	1.0	0.040

21. Remove the upper cap and bearing cup. Fill the bearing with grease, fit the correct number of shims, replace the cap.
22. Apply lubricating oil to the threads of the bolts and tighten to a torque of 52 lbf.ft (70Nm).
23. Remove the lower bearing cap and cup and fill the bearing with grease. Tighten the bolts as described in procedure 22.
24. Grease both bearings with a grease gun to ensure that they are full.
25. Apply lubricating oil to the thread and tighten the ball joint nut to a torque of 78 lbf.ft (106 Nm). Then tighten further as required to align the nut for the split pin. Renew the split pin.

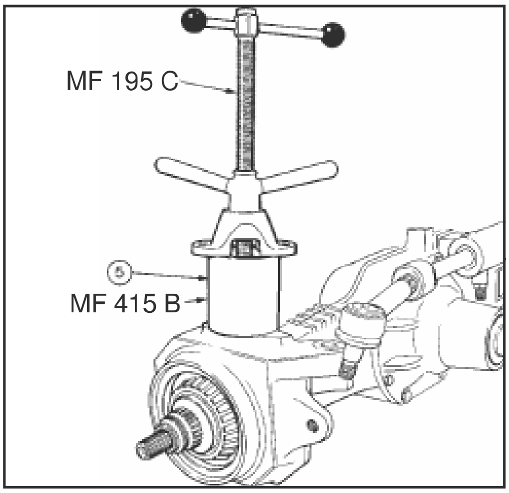

Fig 21

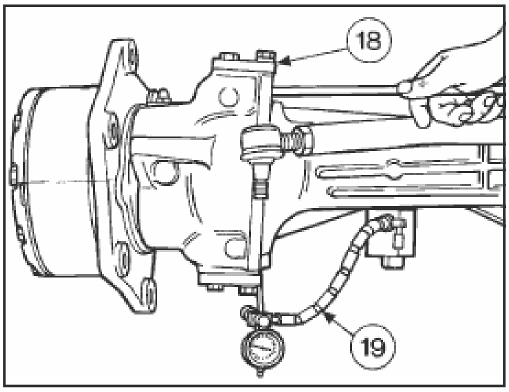

Fig 22

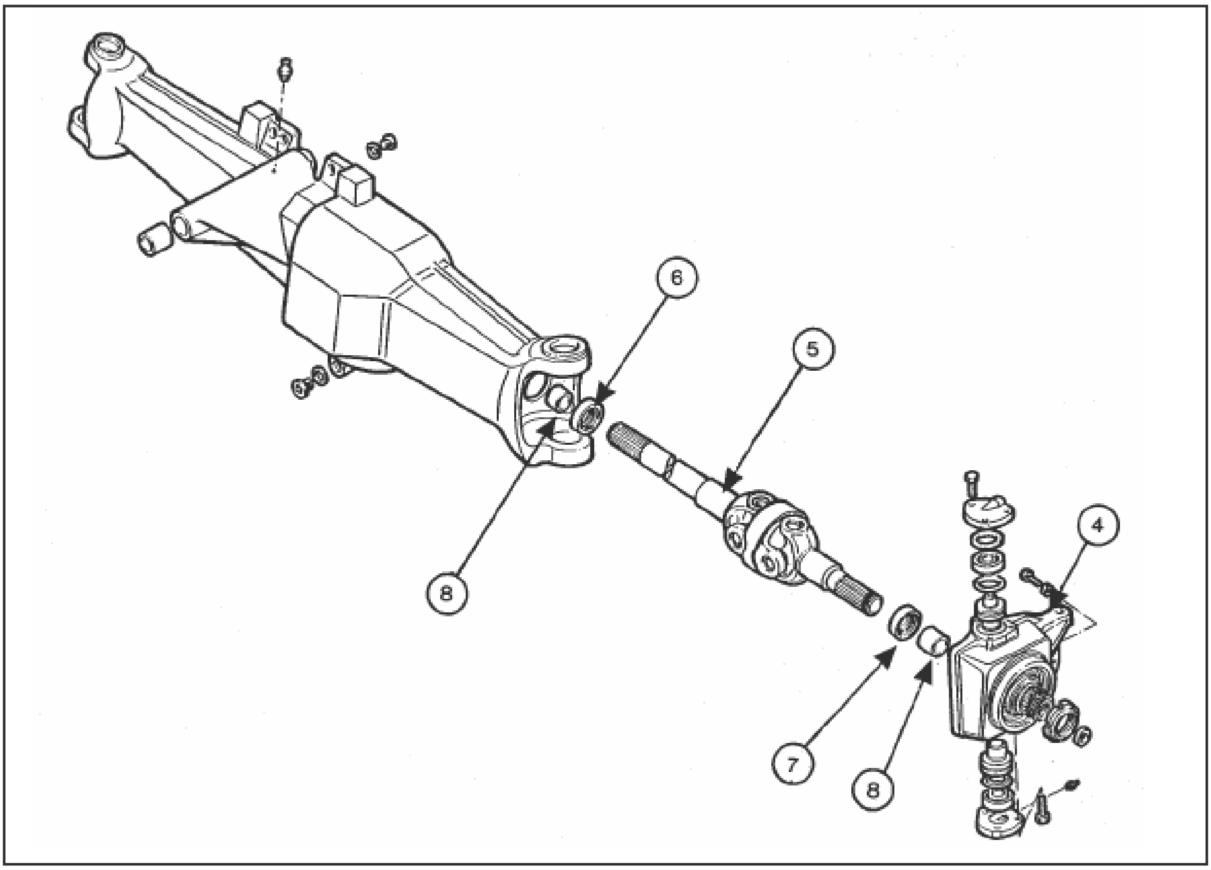

Fig 23

7C.8 DRIVE SHAFT AND OIL SEALS

Removal and refitment

Removal

1. Drain some of the oil from the axle casing.
2. Remove the planetary carrier, see operation 7C.4.
3. Remove the circlip and sun gear.
4. Remove the swivel housing, see operation 7C.7.
5. Remove the drive shaft from axle casing.
6. Lever the seal out of the axle casing, if necessary.
7. Lever the seal out of the pivot housing, if necessary.
8. Remove the drive shaft bushings, if necessary.

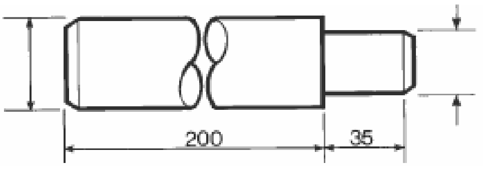

Fig 24

Examination : Carefully inspect the universal joints in the drive shaft, if there is any sign of wear renew the joints or fit new shafts.

Refitment

9. Fit new seals in the axle casing and swivel housing. It is recommended that a special tool is made to carry out this operation. The illustration gives the dimensions for the tool. This tool can be used to fit new drive shaft bushes in the axle casing and swivel housing if required.
10. Place the bushing on the special tool and drive it into the housing. The bushes must be fitted with the split line at three 'o'clock, see illustration, and installed to a depth of 0.0787 inch (2 mm) behind the oil seal facing.
11. Fit a new dust seal to the crownwheel and pinion side of the drive shaft.
12. Reverse procedure 1 to 5 except:

    a. Refill both the axle and planetary carrier to the correct level with an approved oil.

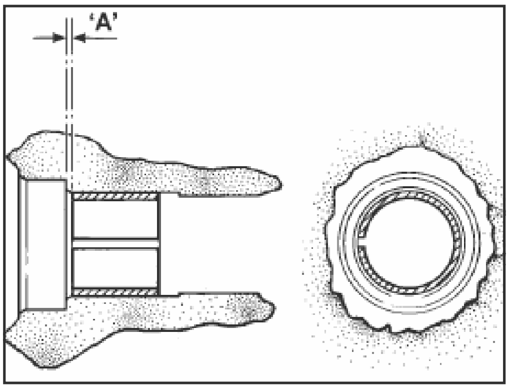

Fig 25

7C.9 DRIVE SHAFT

Overhaul

Dis-assembly

1. Remove the drive shaft, see operation 7C.8.
2. Hold the inner section of the drive shaft in a soft faced vice.
3. Remove the four circlips from each end of the universal joint.
4. Using a hammer, drive the central yoke downwards until the bearing sleeve protrudes.
5. Clamp the bearing sleeve in a vice and tap the central yoke from the bearing.
6. Remove the opposing bearing sleeve in the same way and remove the outer section of the shaft.
7. Turn the shaft assembly through 90 °, then repeat procedures 4 to 6 to free the other universal joint from the shaft.
8. Grip the outer section of the drive shaft in a vice and repeat procedures 2 to 7.

Examination : Pay particular attention to the axle shaft splines. Inspect all components and renew any which show signs of wear or damage. Always renew the universal joint as an assembly including the joint, bearings, caps, circlips and seals.

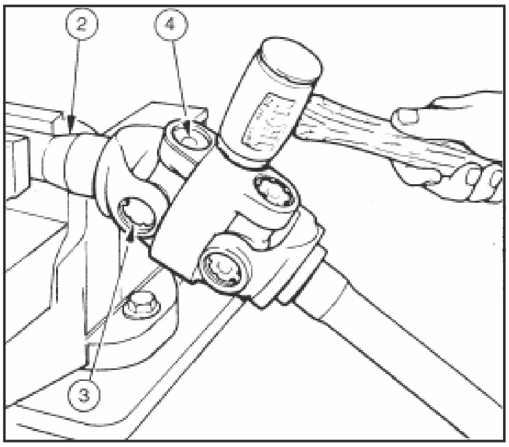

Fig 26

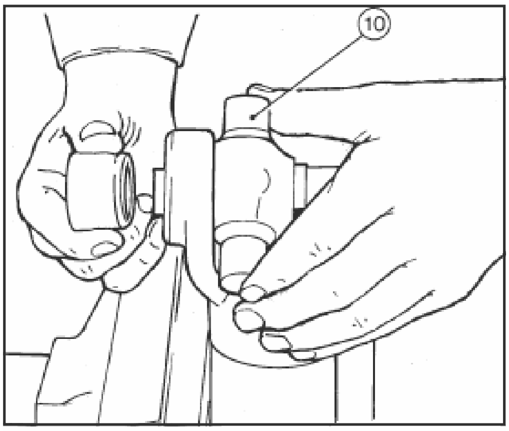

Fig 27

Re-assembly

9. Ensure that the needle rollers are held in place with a little grease in the bearing sleeve.
10. Position the cross within the yoke and move it sideways as far as possible to provide a guide for the needle rollers in the bearing sleeve when being refitted.
11. Slide the bearing sleeve onto the cross and drive the bearing into the yoke deep enough to permit the insertion of the circlip.
12. Assemble the remaining sleeves and universal joint in a similar method.
13. Thoroughly lubricate the universal joint with a grease gun after completing assembly and before fitting to the axle.
14. Refit the drive shaft to the axle.

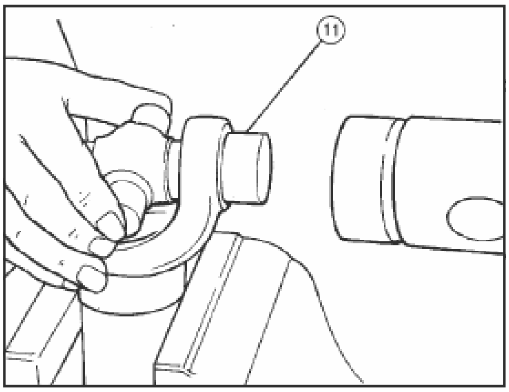

Fig 28

7C.10 PINION OIL SEAL

Removal and Refitment

Special Tools:

MF.480 Pinion nut wrench

Removal

1. Apply the tractor parking brake.
2. Place a container under the axle and drain some of the oil from the casing.
3. Slacken the two hose clips and slide back the drive shaft guard.
4. Slacken the front guard hose clip and slide the guard forward.
5. Remove the four bolts and disconnect the universal joint.
6. With a small hammer and cold chisel carefully chisel away the lip of the pinion nut which has been driven down into the slot.
7. Using special tool MF.480 pinion nut wrench, remove the pinion nut.
8. Remove the drive coupling.
9. Remove the 'O' ring and discard.
10. Lever the oil seal out of the casing

Refitment

11. Make the special seal tool as shown in the illustration on page 7C -19.
12. Renew the oil seal.

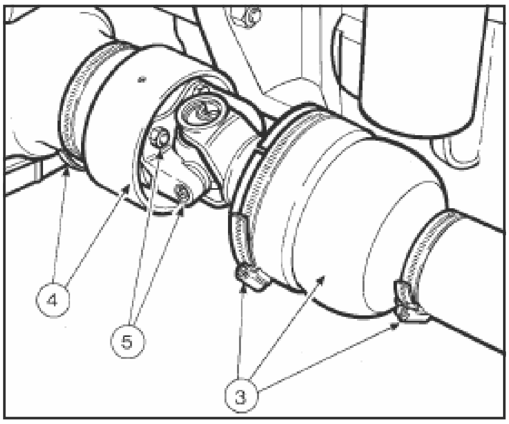

Fig 29

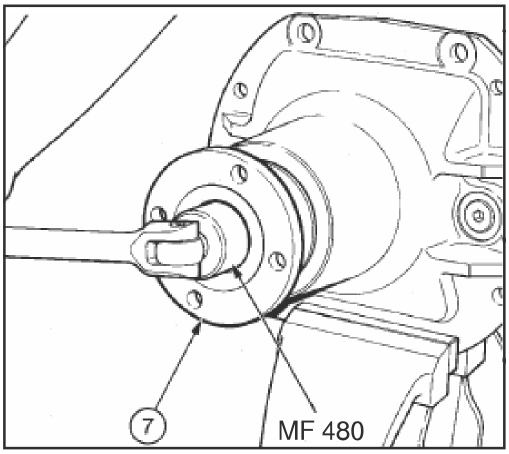

Fig 30

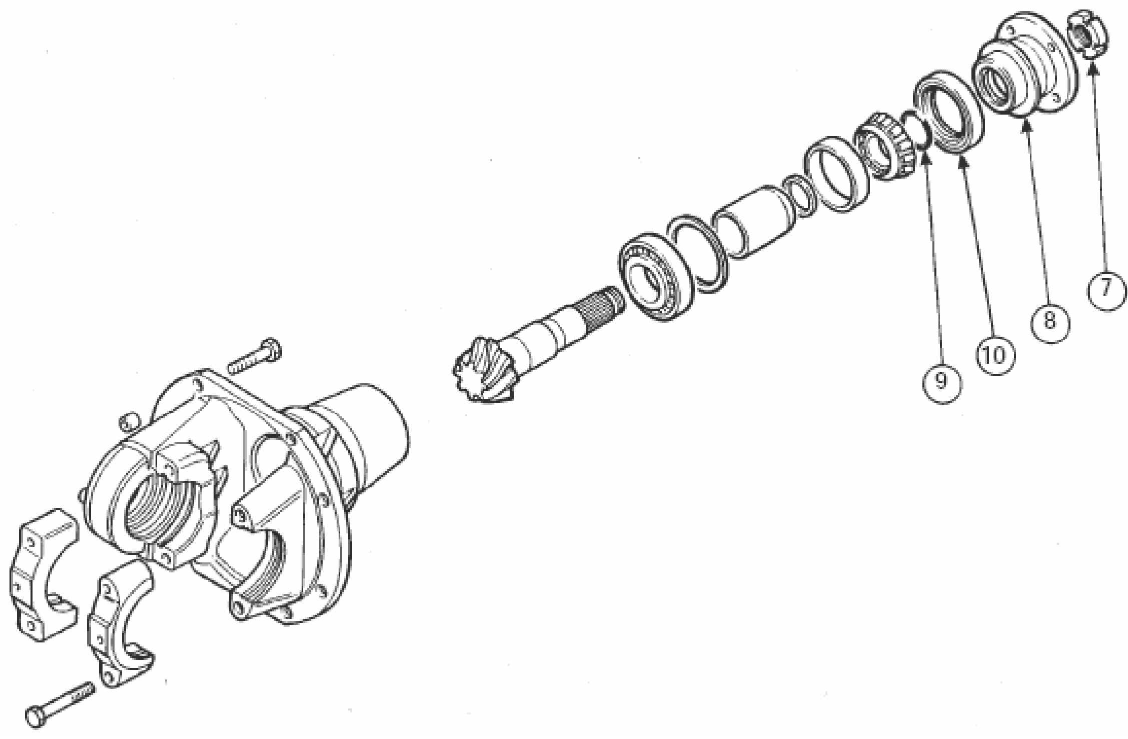

Fig 31

13. Renew the shaft 'O' ring.
14. Apply general purpose grease to the cavity of the oil seal
15. Replace the drive coupling.
16. Renew the pinion nut and tighten dry to a torque of 218 lbf.ft (295 Nm) using special tool MF.480.
17. With the aid of a hammer and punch drive the lip of the nut into the slot on the shaft to lock it.
18. Reconnect the drive shaft and guard, see operation 7C.3.
19. Refill the axle case with an approved oil to the correct level.

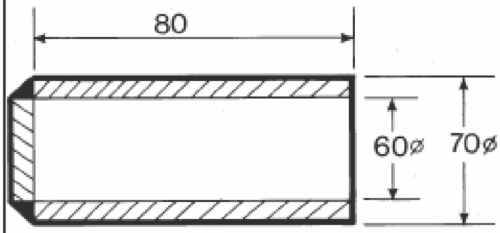

Fig 32

7C.11 DIFFERENTIAL ASSEMBLY

Removal and refitment

Removal

1. Secure the tractor by applying the parking brake.
2. Jack up the front of the tractor and support under the engine.
3. Slide back the drive shaft guard and disconnect the drive shaft, see operation 7C.8.
4. Remove the axle from the tractor, see operation 7C.3.
5. Remove both front wheels.
6. Drain the oil from the axle casing.
7. Remove both swivel housings, see operation 7C.7. It is not necessary to dismantle the planetary hubs.
8. Remove the steering ram, see operation 7C.14.
9. Remove the eight bolts holding the differential case to the axle casing.

WARNING: Take care when removing the differential assembly, it is awkward and heavy to handle.

10. The differential is located by dowels in the axle casing. Carefully pry it away from the casing supporting the weight at all times.

Refitment

11. Reverse procedure 1 to 10 except:

    a. Apply Massey Ferguson Instant Gasket (Loctite 515) to the joint face of the differential case.

    b. Apply lubricating oil to the differential case bolts and tighten them to a torque of 52 lbf.ft (70Nm).

7C.12 DIFFERENTIAL ASSEMBLY

Overhaul

Special Tools:

MF.471 Hydraulic spring compressor

Dis-assembly

These instructions cover two types of differential, the standard type and Hydralock. The Hydralock type is a hydraulic method of locking the differential.

The Hydralock assembly may be fitted to the axle but not used, a plug will be fitted in place of the hydraulic connection.

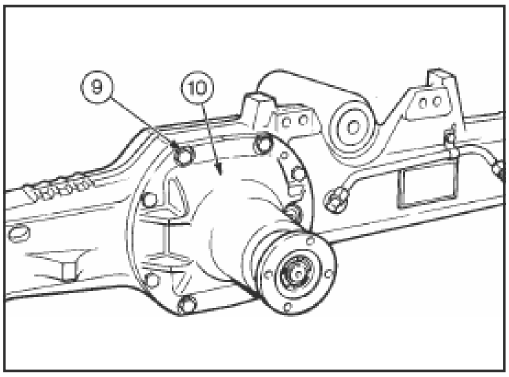

Fig 33

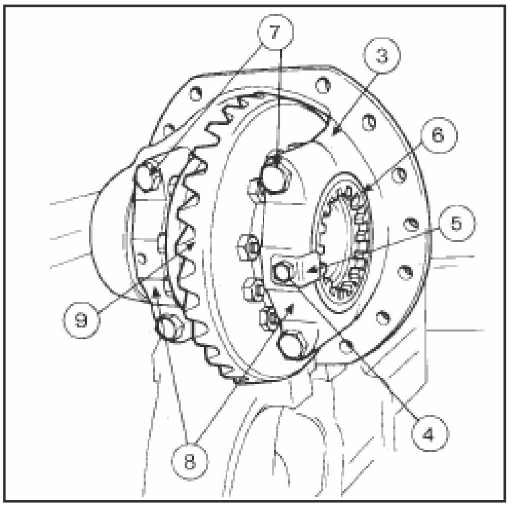

Fig 34

1. Remove the differential assembly, see operation 7C.11.
2. Hold the differential assembly in the jaws of a vice.
3. Mark the end caps and casting to aid re-assembly.
4. Remove the securing bolt.
5. Remove the locking tab.
6. Unscrew the bearing adjustment ring nut.
7. Remove the cap bolts.
8. Remove the end caps.
9. Lift the differential assembly out of the casing.
10. Remove the bearing cups.
11. Remove the shims and retain for re-assembly.
12. Remove the retaining ring.

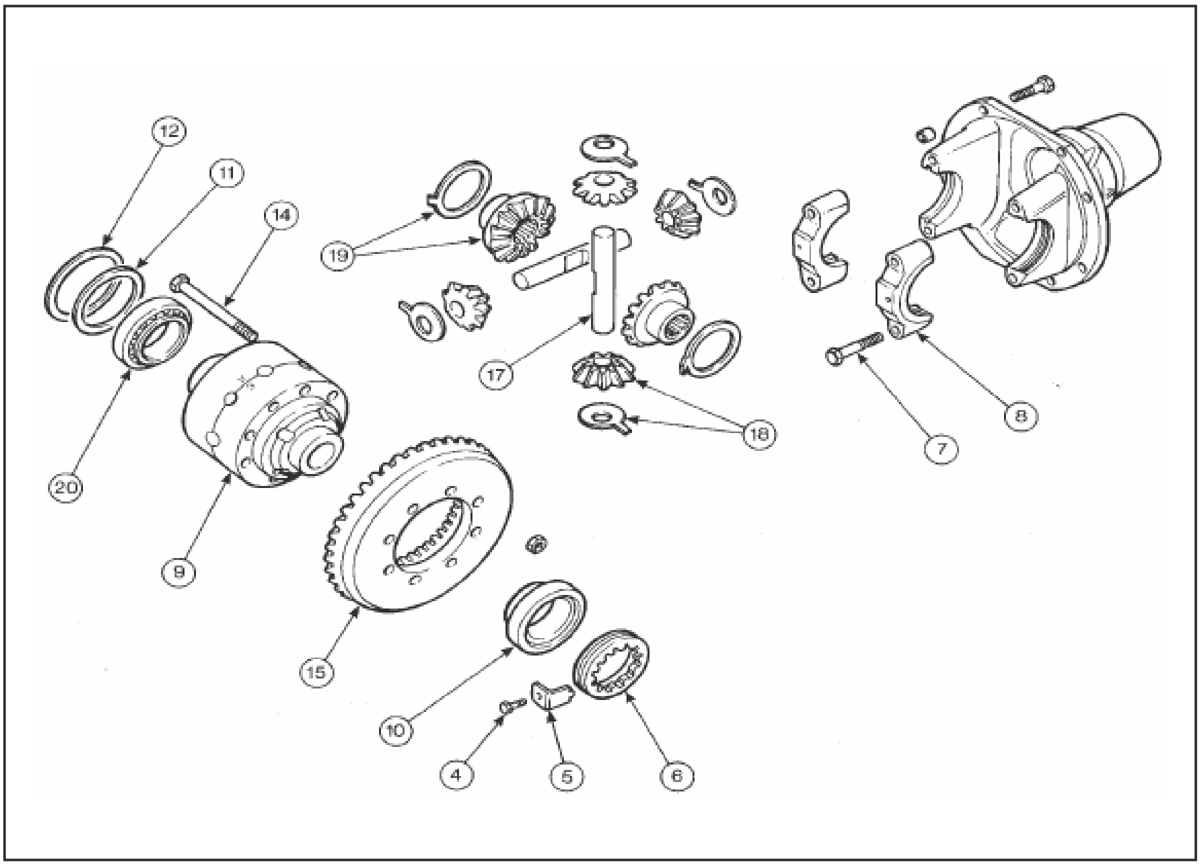

Fig 35

13. Mark the two halves of the differential case and the crown wheel to aid re-assembly.
14. Place the crownwheel and differential unit in the vice and remove the eight nuts and bolts.
15. Remove the crownwheel.
16. Split the differential case.
17. Remove the differential cross.
18. Remove the differential gears and side washers.
19. Remove the differential side gears and thrust washers.
20. Remove the taper roller bearing cones from the differential housing.

    Examination : Thoroughly clean and inspect all components. Any parts showing signs of wear or damage must be renewed. Renew all 'O' rings, seals and circlips.

Re-assembly

21. Refit the retaining ring.
22. Refit the removed shims.

Crownwheel and differential

23. Refit or renew the taper roller bearing cones if they have been removed.
24. Refit the differential gears, cross and thrust washers to the case.
25. Align the previously made marks on the case and the crown wheel if the original wheel is being re-used. Refit the eight bolts, apply Massey Ferguson Stud Lock (Loctite 270) to the threads and tighten to a torque of 112 lbf.ft (83 Nm).
26. Refit the bearing cups and refit the crownwheel and differential assembly. The crownwheel is mounted on the left side of the differential.
27. Refit the bearing caps and lightly tighten the bolts.

Bearing pre-load

28. Tighten the adjuster ring to take up the backlash between the taper roller bearings.
29. Finally, turn the adjuster ring a further three notches until the slot is aligned with the locking plate to apply the correct pre-load.

Crownwheel and pinion backlash

30. With a dial indicator gauge check the backlash between the crown wheel and the pinion. Fit the indicator gauge as shown in the illustration, the clearance should be from 0.0051 - 0.007 inch (0.13 to 0.18mm).
31. If the reading is too high or too low it will be necessary to move the crown wheel and differential to the left or right depending upon the clearance. Maintain the pre-load by unscrewing and screwing-up both rings by the same amount to obtain the clearance required.

Part number	Thickness	
	mm	inch
3428 747 M1	0.10	0.004
3428 748 M1	0.15	0.006
3428 749 M1	0.30	0.012
3428 750 M1	0.50	0.020
3428 751 M1	0.70	0.028
3428 752 M1	1.00	0.040

Check the thickness of the pack with a micrometer.

32. When the setting is correct remove each cap bolt in turn and apply Massey Ferguson Stud Lock (Loctite 270) to the thread. Tighten the bolts to a torque of 105 lbf.ft (143Nm).
33. Replace the locking tab and bolt.
34. Check the rotation of the crown wheel and pinion to ensure satisfactory operation.
35. Refit the differential unit to the axle casing.

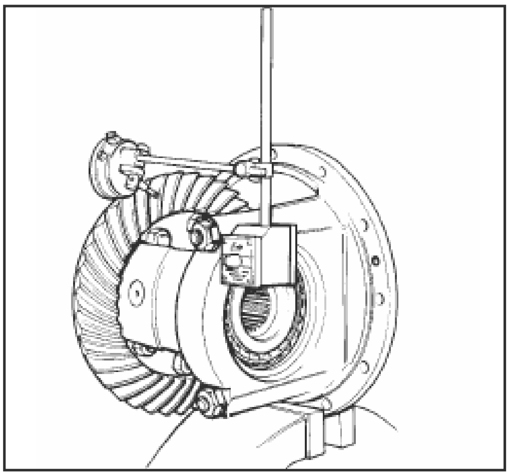

Fig 36

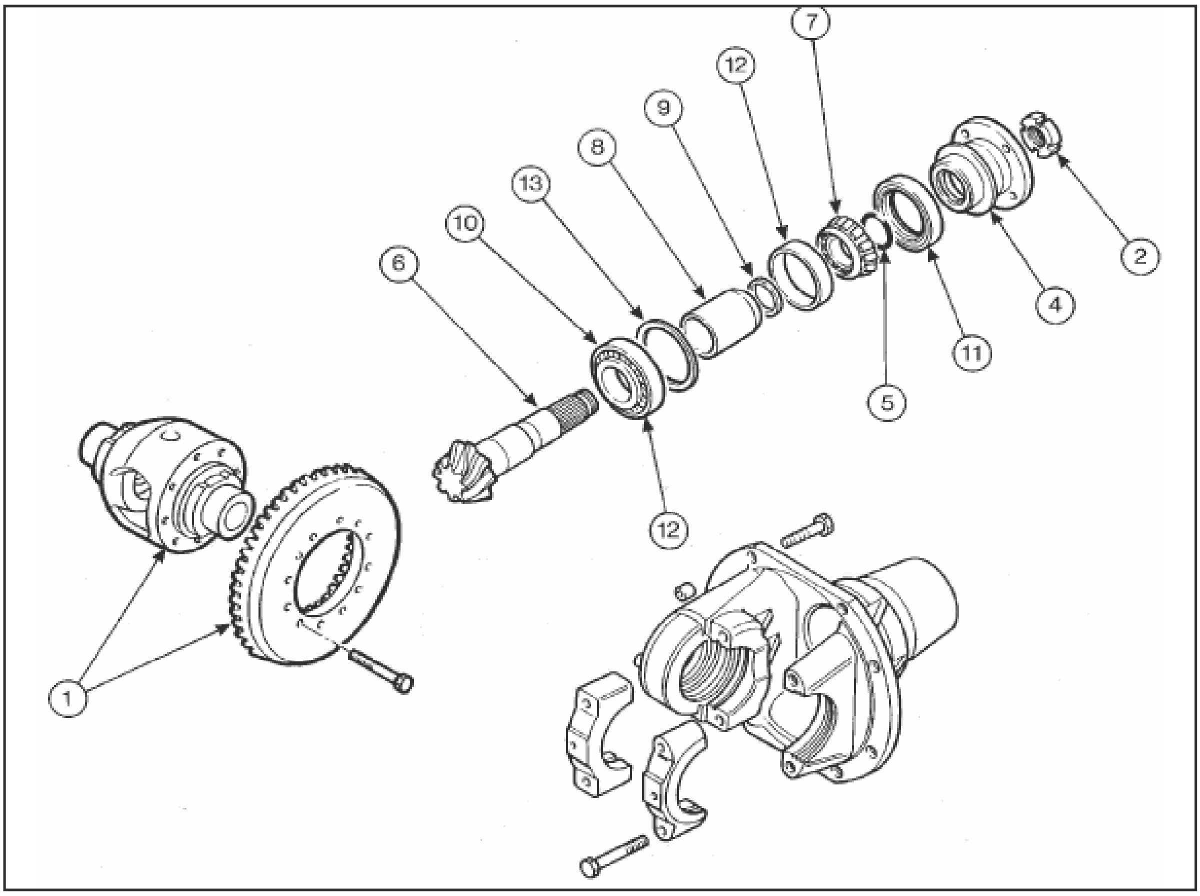

Fig 37

7C.13 CROWNWHEEL AND PINION

Overhaul

Special Tools:

MF.480	Pinion nut wrench
FT.4062A	Pinion pre-load gauge

Dis-assembly

1. Remove and dismantle the crownwheel and differential assembly, see operation 7C.12.
2. With a narrow cold chisel and hammer carefully unstake the pinion nut securing it to the pinion shaft.
3. Using special tool MF.480 pinion nut wrench, remove the pinion nut.
4. Remove the drive coupling.
5. Remove the 'O' ring and discard.
6. With the aid of a soft faced hammer or press remove the pinion with bearings from the case.
7. Remove the outer bearing cone.
8. Remove the spacer.
9. Remove the bearing pre-load shims and retain for re-assembly.
10. Remove the inner bearing cone with a bearing separator plate and press.
11. Remove the oil seal.
12. Remove the inner and outer bearing cups.
13. Remove the pinion depth of mesh shims.

Examination: Thoroughly clean and inspect all components. Any parts showing signs of wear or damage must be renewed.

Renew all 'O' rings, seals and circlips. Ensure that all parts are free from dents or damage.

Re-assembly

The crownwheel and pinion are only available as a matched set. If the crownwheel and pinion are not to be replaced the following instructions on setting the pinion may be disregarded. The two sets of shims must be retained for re-assembly.

It is necessary to carry out a series of measurements and calculations and procedures to establish the exact position of the pinion in relation to the crownwheel and the pinion bearing pre-load. It is recommended that you work in the metric system for ease of calculation.

Pinion settings - depth of mesh

14. The height of the pinion is adjusted by shims under the taper roller bearing to obtain dimension 'A'. The shims required are calculated in accordance with the following formula:

    Sp = A- (D ± R)

    Sp = Shim thickness.

    A = Actual dimension from centre line of crown wheel to the top of the taper roller bearing without shims.

    D = Nominal dimension of 3.58 inch (91mm).

    R = Actual tolerance of dimension 'D' etched on the bevel pinion. This value may be a positive (+) or a negative (-) to be added or subtracted from the nominal dimension 'D'.

    For the next series of operations you will require a precession depth gauge.

15. Fit the upper taper roller bearing cup and cone into the housing without shims.
16. Place the housing in the vertical position on the bench. Place a straight edge across the bearing cap faces and measure from the top of the straight edge to the top of the bearing. Subtract the width of the straight edge from your reading and record dimension 'A'.
17. Dimension 'D' is a fixed dimension of 3.582 inch (91mm) which must always be adhered to.
18. Inspect the end of the pinion and record tolerance 'R', plus or minus.
19. Using the figures you have obtained above and the formula calculate the shim thickness required.

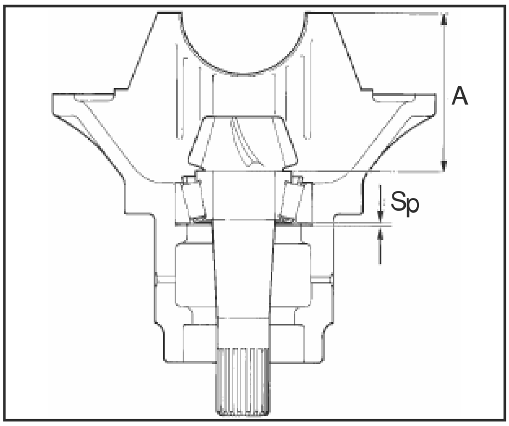

Fig 38

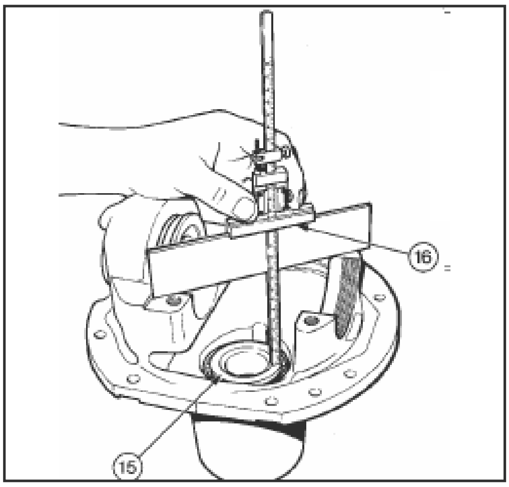

Fig 39

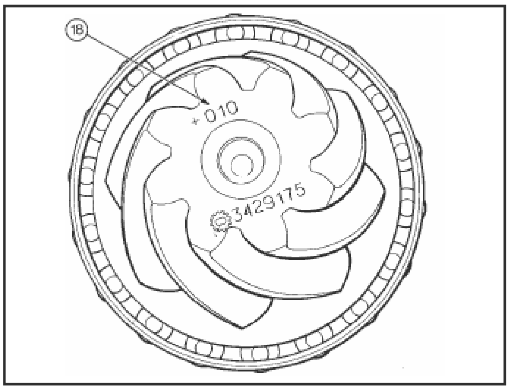

Fig 40

Example:

Where A = 3.620 inch (91.96mm) (measured).

D = 3.582 inch (91mm) (nominal).

R = +0.0003 inch (+0.010mm) (tolerance).

Sp = 3.620 inch (91.96mm) less (3.582 inch (91mm) +0.0003 inch (+0.010mm).

Sp = 0.0374 inch (0.95mm).

Shims required:- 1 x 0.15. 1 x 0.3 and 1 x 0.5.

Check the thickness of the pack with a micrometer. It may be necessary to round-off to the nearest value that can be made into a shim pack. Select the higher value if new bearings are being fitted. Shims are available in the following sizes:

Part number	Thickness	
	mm	inch
3428 722 M1	0.1	0.004
3428 723 M1	0.15	0.006
3428 724 M1	0.3	0.012
3428 725 M1	0.5	0.020
3428 726 M1	0.7	0.028
3428 727 M1	1.0	0.040

20. Remove the bearing, place the shim pack into the housing and fit the inner taper roller bearing cup.
21. Fit the outer taper roller bearing cup.
22. Press the inner taper roller bearing cone on to the pinion.
23. Replace the bearing spacer with the chamfered end facing the drive coupling.
24. Replace the shims that were removed on dis-assembly as a starting point, bearing cone, coupling and a new nut. DO NOT fit the oil seal.
25. Tighten the nut dry to a torque of 218 lbf.ft (295 Nm). Tap the pinion in both directions to ensure that the bearings are fully seated.
26. Lightly lubricate the bearings.

Pinion bearing pre-load

27. It is now necessary to set the taper roller bearing pre-load by selecting the correct shims to be placed between the spacer and outer bearing. The correct rotational torque is 18 lbf.inch (2 Nm). This can be determined by using special service tool FT 4062A or making a special gauge as shown in the illustration.
28. Special service tool FT 4062A is calibrated in pounds force inches (lbf in.) moving the 2 lb weight to the 18 inch. mark on the rod represents 18 lbf.inch (2Nm).
29. Alternatively, select a length of flat bar and cut off 450mm. Drill two 10mm diameter holes 80mm apart in the center of the bar. Cut a notch 200mm from the center in the top of the bar. Obtain a weight of 2.204 lbs (1 Kg), if this is not available, cut a 63mm length of 50mm diameter steel bar and attach a length of cord to the top.
30. Attach special tool FT.4062A, or bolt the tool you have made to the drive coupling with two bolts. With the bar horizontal hang the weight from the notch, this is equal to a rotational torque of 18 lbf.inch (2Nm).

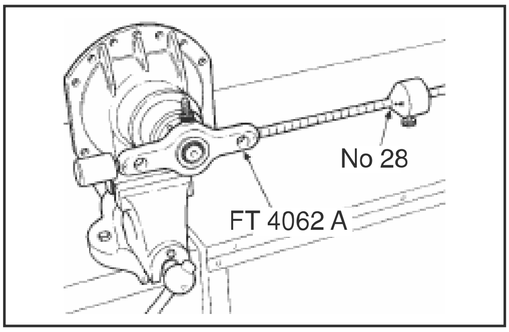

Fig 41

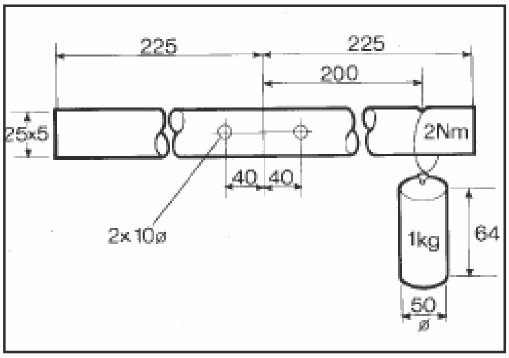

Fig 42

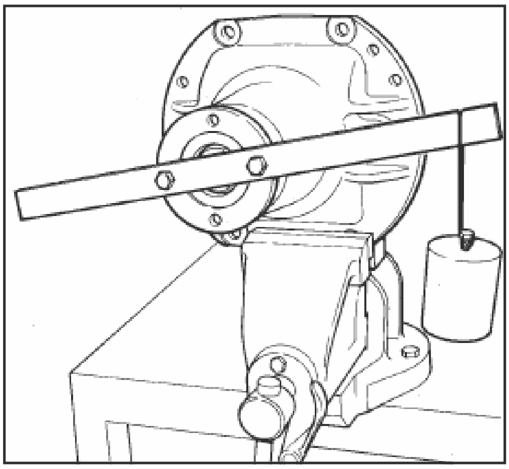

Fig 43

31. The setting is correct when you touch the weight end of the bar or tool and it slowly rotates from the horizontal to the vertical position. To obtain this condition it may be necessary to adjust the shim thickness several times. Shims are available in the following thicknesses:

Part number	Thickness	
	mm	inch
3428 253 M1	0.1	0.004
3428 254 M1	0.15	0.006
3428 255 M1	0.3	0.012
3428 256 M1	0.5	0.020
3428 257 M1	0.7	0.028
3428 258 M1	1.0	0.040

32. Renew the oil seal using the special tool described in section 7C.10.
33. Renew the shaft 'O' ring.
34. Apply general purpose grease to the cavity of the oil seal.
35. Replace the drive coupling.
36. Replace the pinion nut. Make up a suitable holding tool and tighten the nut to a torque of 218 lbf.ft (295Nm) using special tool MF.480.
37. With the aid of a hammer and punch drive the lip of the nut into two opposite slots on the shaft to lock it.
38. Replace the crown wheel and differential assembly setting the clearance as described in operation 7C.12.
39. Rebuild the axle and refit to the tractor.

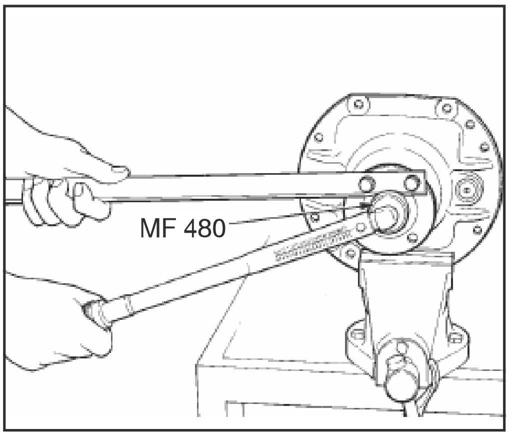

Fig 44

7C.14 STEERING RAM

Removal and refitment

Removal.

1. Remove the front axle assembly, see operation 7C.3.
2. Remove the split pins and disconnect both steering ball joints.
3. Holding the ends of the steering ram piston rod with a spanner unscrew both track rods.
4. Remove the four hexagon cap screws (8mm hexagon wrench will be required) and the steering ram.

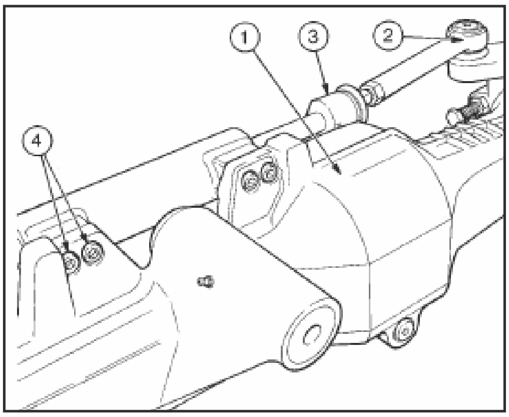

Fig 45

Refitment

5. Reverse procedure except:

   a. Tighten the four cap screws to a torque of 79 lbf.ft (107Nm).

   b. Tighten the steering ball joint nuts to a torque of 78 lbf.ft (106Nm).

   c. Check the wheel alignment, see operation 7C.1.

   d. Use new split pins when refitting the steering ball joints.

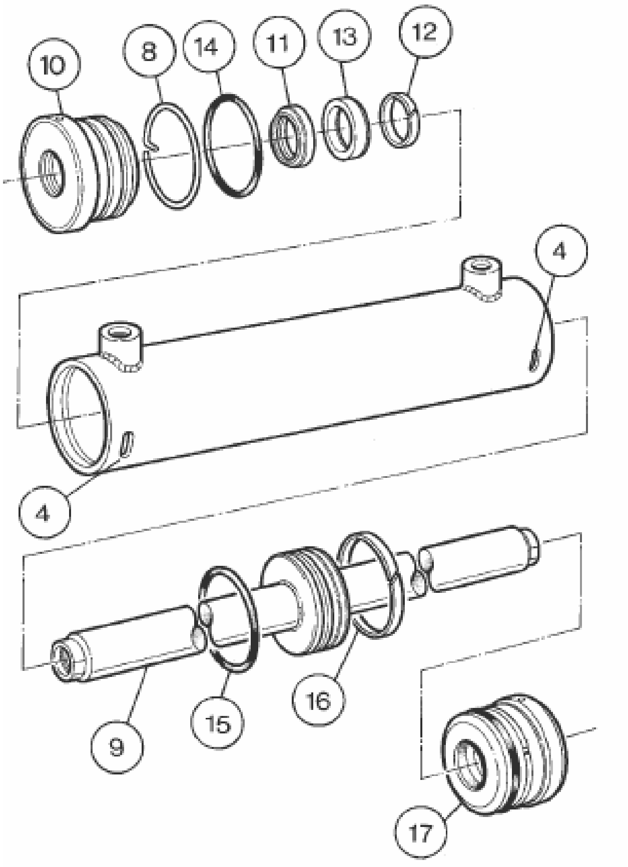

Fig 46

7C.15 STEERING RAM

Overhaul

Special Tools:

MF.482	Steering ram wrench

Dis-assembly

1. Remove the steering ram, see operation 7C.14.
2. Remove any sealing plugs and drain out any oil in the ram cylinder by moving the piston from one end of the cylinder to the other. Hold the cylinder over a container during this operation.
3. Hold the ram cylinder in a vice by one of the mounting bosses.
4. Remove the sealing compound in the elongated holes at each end of the cylinder.
5. Using special tool MF.482 steering ram wrench, engage the small end of the wrench in the two slots in the cap. Rotate the cap until the chamfered end of the retaining wire can be seen in the elongated hole.
6. With the aid of a screwdriver, turn the end cap and pry the end of the wire up out of the hole.
7. Continue turning the cap and wind the rest of the wire out through the hole.
8. The end of the wire has a right angle bend which locates in a hole in the groove of the end cap, remove the wire from the ram cylinder.
9. Withdraw the piston assembly from the ram cylinder with the end cap.
10. Remove the end cap.

11. Remove the wiper seal.
12. Remove the wear ring.
13. Remove the pressure seal.
14. Remove the 'O' ring.
15. Remove the piston seal.
16. Remove the piston wear ring.
17. Remove the end cap from the other end of the ram cylinder following procedures 5 to 14.

    Examination : Clean and inspect all parts, renew any that are worn or damaged. Renew all seals, wear rings and 'O' rings.

Re-assembly

18. Fit a new set of seals in one of the end caps and lubricate them with transmission oil.
19. Renew the seal and wear ring on the piston and lubricate.
20. Refit the piston to the ram cylinder and slide the cap down into the cylinder.
21. Using wrench MF.482 rotate the end cap until the hole in the wire groove is visible through the hole in the side of the ram cylinder.
22. Insert a new wire so that the bent end locates in the hole in the end cap. Ensure that the two grooves in the ram cylinder and end cap are in line.
23. Rotate the end cap so that it draws the wire round the end cap inside the ram cylinder. Rotate until all the wire is in the cylinder.
24. Seal the elongated hole in the ram cylinder with a non-setting type sealing compound. This sealing operation is important to prevent the ingress of water and the resultant rusting of the end cap and retaining wire.
25. Repeat the operations 20 to 24 for the other end cap.
26. Check that the piston rod moves up and down the ram cylinder correctly.
27. Refit the steering ram to the tractor.

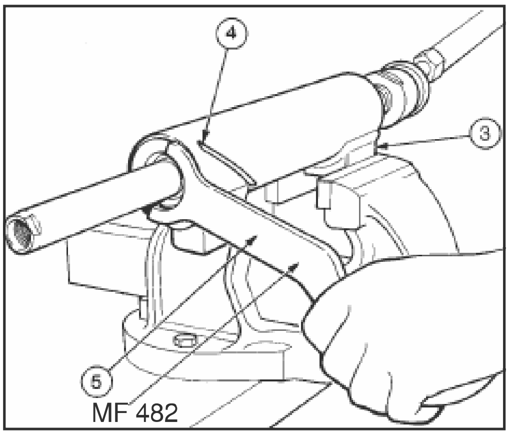

Fig 47

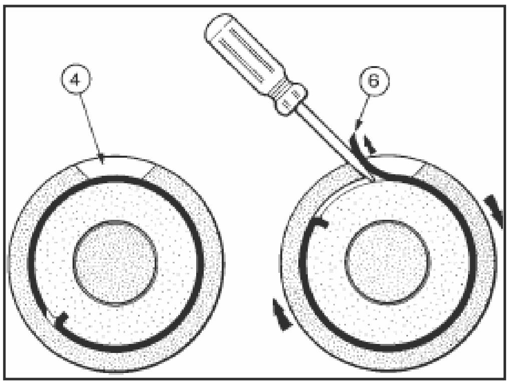

Fig 48

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SECTION 8

Clutch

INDEX

8A DUAL CLUTCH

Part A

Dual Clutch

Table of Contents

Operation No.	Description			Page No.
8A.1	Specification	...	...	8A - 3
8A.2	General Description	...	...	8A - 4
8A.3	Clutch Pedal Free Play	...	...	8A - 5
8A.4	PTO Clutch	...	...	8A - 5
8A.5	Dual Clutch Assembly	...	...	8A - 6
8A.6	Clutch Release Bearing	...	...	8A - 8
8A.7	Clutch release mechanism	...	...	8A - 9
8A.8	Fly wheel pilot bearing	...	...	8A - 10
8A.9	Fault finding chart	...	...	8A - 10

8A. 1 SPECIFICATION

Clutch Primary Plate Diameter	12 inch (305 mm)
Clutch Secondary Plate Diameter	10 inch (254 mm)
Clutch Disc thickness – Primary plate	0.362 inch (9.22 mm)
Clutch Disc thickness – Wear tolerance	0.098 inch (2.50 mm)
Clutch Disc thickness – Secondary Plate	0.314 inch (8 mm)
Clutch Disc thickness – Wear tolerance	0.078 inch (2 mm)
Primary Pressure plate Coil Spring	For MF 2605 - 6 Springs
	For MF 2615 - 9 Springs

Special Tools

SER / 054	Tractor Split kit
SER / 011	Clutch Centraliser
SER / 081	PTO Clutch Setting Gauge
SER / 006	Release Lever height gauge (12 inch).
SER/168	Clutch dismantling / assembling tool
SER/053	Clutch remover / assembly fixture
SER/081	PTO Clutch setting gauge.

Torque Values

Clutch cover to flywheel	30 Nm (22 lbs. ft.)
Transmission case to engine	75 Nm (55 lbs. ft.)
Clutch adjusting set screw	27 – 37 Nm (20 – 27 lbf ft.)
Fly wheel bolts	100 Nm (74 lbs.ft)

Recommended Lubricants for Smearing Clutch Splines

Make	Type
SHELL	Retinax OX
GULF	High temperature Grease No. 3
ESSO	Univex N3
CASTROL	BNS
BP	Energrese HTB2 or B2
TOTAL	Exteup or Coloris 3

8A. 2 GENERAL DESCRIPTION

Dual Clutch (Fig. 1)

The dual clutch enables the drive to the gearbox and rear wheels to be disconnected without interrupting the drive shaft to the linkage pump and power take off which remains “live”. The clutch second stage allows for disconnection of the drive to the PTO and hydraulics. During operation, the main friction disc (22) is held against the engine flywheel by the main pressure plate (2) under the force of coil springs (11). The PTO friction disc (21) is held against a false flywheel (19) by the PTO pressure plate (3) under the force of a Belleville spring disc (12).

Depressing the clutch pedal through its first stage of travel causes the release bearings to move three release levers which are pivot mounted to the clutch cover. Movement of these levers pulls the main pressure plate (2) rearwards against the force of coil springs and so disengages the drive from the main friction disc (22).

Depressing the clutch pedal into the second stage brings setscrews on the main pressure plate (2) into contact with the PTO pressure plate (3). Further pedal movement forces the PTO pressure plate (3) rearwards against the force of its Belleville spring and disengages the main drive from the PTO friction disc (21) to the pump and PTO.

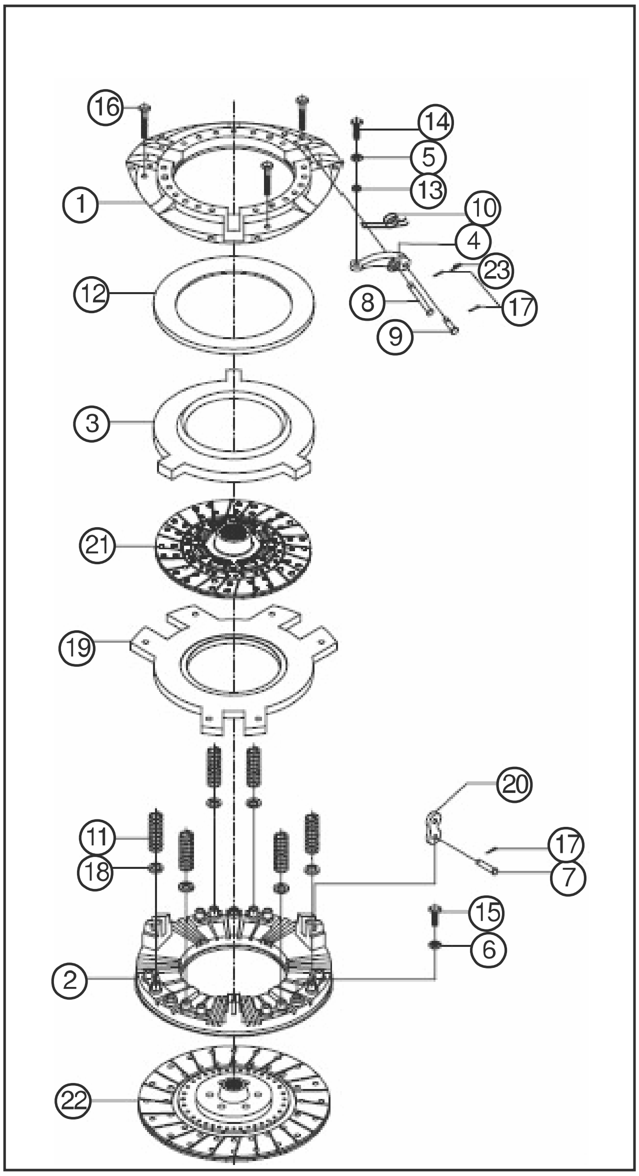


Fig 1

1.	Cover plate
2.	Pressure plate main
3.	Pressure plate PTO
4.	Release lever
5.	Hex.nut on lever
6.	Hex nut on Pressure Plate
7.	Release levers pin pressure plate link
8.	Release lever pin (link lever)
9.	Release lever pin (lever cover)
10.	Anti rattle spring
11.	Pressure spring
12.	Belleville spring
13.	Spring washer
14.	Adjusting screw
15.	Release screw
16.	Transporation screw
17.	Split pin
18.	Insulator
19 .	Secondary fly wheel (False fly wheel)
20 .	Link
21.	Driven plate (PTO)
22.	Driven plate (Main drive)
23 .	Hair pin spring

8A. 3 CLUTCH PEDAL FREE PLAY

Adjustment

1. Slacken the clamp bolt (Item 1 in Fig. 2) and insert a pry bar in the hole at the end of the clutch operating shaft (Item 2 in Fig. 2).
2. Insert the 4mm wedge in between the clutch pedal lever and the stopper plate (Ref Fig 2A).
3. Rotate the clutch operating shaft clockwise, until resistance is felt and re-tighten the clamp bolt (Item 1 in Fig. 2) by holding the pry bar in same position.
4. Remove the pry bar and the wedge and this will give a free travel of 25 mm (1 inch) in the clutch pedal pad.
5. Press the clutch pedal down through full travel five times. Check the free travel again and re-adjust, if necessary.

   NOTE : *It is essential that the stop plate is fitted correctly as follows*

   Clutch pedal free play should be

   Split torque clutch - 25 mm (1 inch)

   Dual clutch - 16 mm (0.629 inch)

   Check the clutch adjustment every 100 hours.

   When the tractor enters service or has new clutch linings fitted, the clutch must be carefully bedded in. The clutch pedal play must be checked frequently during the first 50 hours and necessary adjustments should be made immediately. Subsequent checks must be made at 100 hours intervals.

   NOTE : *Adjust the clutch stopper bolt for effective function of single stage clutch.if necessary.(Refer fig 2B)*

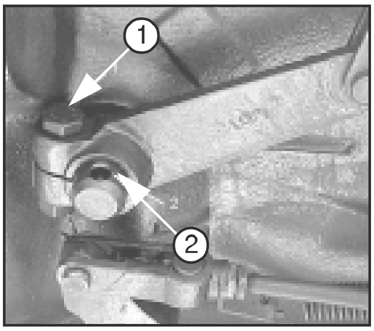


Fig 2

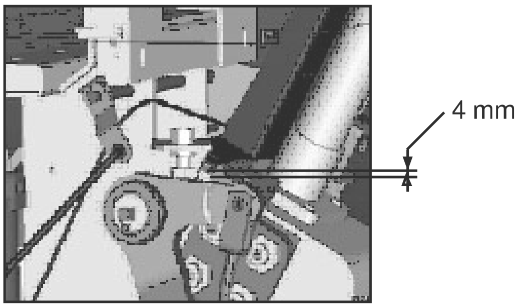


Fig 2A

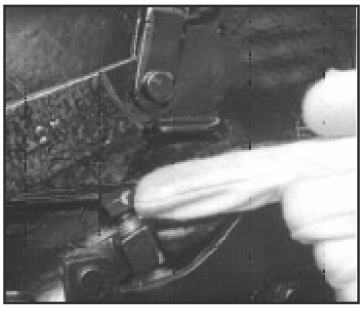


Fig 2B

8A. 4 PTO CLUTCH

Adjustment

WARNING: disconnect the battery terminals and apply parking brake before undertaking adjustment work.

1. Remove the inspection cover from the under side of the clutch housing.
2. Rotate the engine flywheel until one of the three adjusters is visible through the inspection cover opening.
3. Check the gap between screw and PTO clutch pressure plate. If required, adjust the gap to 0.080 ± 0.002 inch (2.032 +/- 0.050 mm)(Dimension ‘A’ in Fig 3) by slackening the nut and then retighten it.
4. Carryout the above steps for remaining two adjusters and refit the inspection cover.

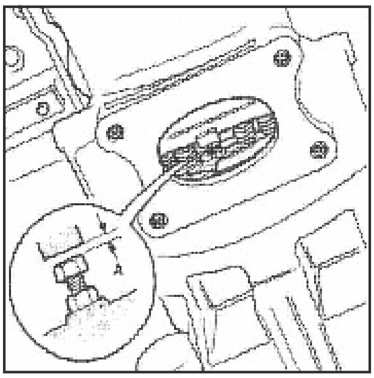


Fig 3

8A. 5 DUAL CLUTCH ASSEMBLY

Removal and Refitment

Special Tools

SER / 011 : Clutch Centraliser

SER/081 : P.T.O. Clutch Setting Gauge

SER / 006 : Lever Height Setting Gauge

CAUTION: The following sequence of instructions must be followed carefully, as spring pressure will cause the clutch cover to fly apart if pressure is not released slowly and evenly.

Removel Sequence

1. Split the tractor between the engine and the Transmission.
2. Fit three slave bolts ¼" UNC x 54 mm (2 1/8 in) to the three equi-spaced holes in the clutch cover and tighten. (Item 2 in Fig. 4)
3. Locate clutch centraliser SER / 011 (Item 8 in Fig. 4) on to the clutch plate hubs and progressively slacken and remove the six bolts and washers. (Item 3 in Fig. 4)
4. Lift the clutch assembly clear of the flywheel. The main friction disc (Item 5 in Fig. 4) will remain separate from the clutch assembly.

Refitment Sequence

1. Lightly smear the splines of the friction disc with recommended grease.
2. Locate the main friction disc on the flywheel. (Item 5 in Fig. 4)
3. Position the clutch assembly on the Flywheel.
4. Using SER / 011 Centralise the PTO clutch and the main friction disc. (Item 8 in Fig. 4)
5. Refit the six bolts and washers. Torque to 30 Nm (22 lbs. ft.). (Item 3 in Fig. 4)
6. Remove the three slave bolts (Item 2 in Fig. 4) progressively and then remove SER / 011

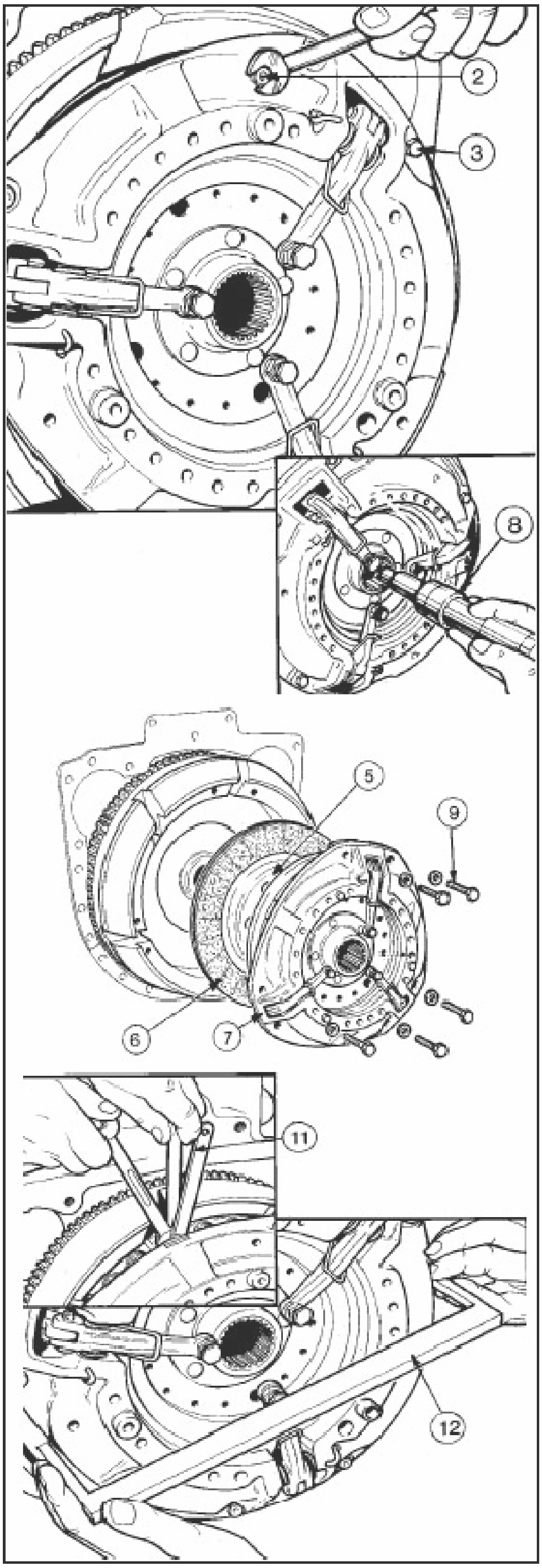


Fig. 4

7. Using SER/081 (Item 11 in Fig. 4), check the clearance between the PTO clutch adjusting setscrews and the PTO pressure plate. Adjust the setscrews as required to 0.080 inch ± 0.002 inch (2.032 ± 0.050 mm). Retighten the locknuts.
8. Using SER / 006 (Item 12 in Fig. 4), check the adjustment of release lever. The domed end of each of the release lever set screw must just touch the gauge. Adjust the set screws as required and re-tighten the locknuts.
9. Join the engine to the rear half of the tractor to complete the assembly.
10. Adjust the clutch pedal free play.

Overhaul

Special Tools:

SER / 011 : Clutch Centraliser

SER/081 : P.T.O. Clutch Setting Gauge

SER / 006 : Lever Height Setting Gauge

SER/053 : Clutch remover / Assembly fixture

Dis-assembly

1. Remove the clutch assembly.
2. Mark all following components to permit their refitment in the same relative positions.

   Cover plate, PTO pressure plate, false flywheel and main pressure plate.
3. Place the clutch assembly on a hydraulic press and locate a suitable bar on top of the cover. (Fig. 5)

WARNING : Ensure that the clutch is located under the press correctly that the bar will not slip and that the press has sufficient travel to allow the spring pressure to completely release. Release the pressure evenly and slowly.

4. Apply pressure until the three 1/4 UNC x 2 1/8 inch long slave bolts can be easily removed. (Item 4 in Fig. 6).
5. Remove the retaining clips from the pivot pins. (Item 5 in Fig. 6).
6. Remove the pivot pins. (Item 6 in Fig. 6).
7. Remove the lever springs. (Item 7 in Fig. 6).

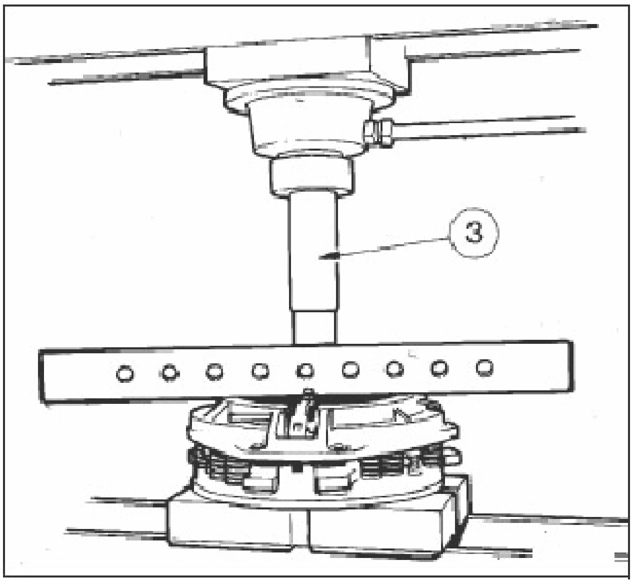


Fig 5

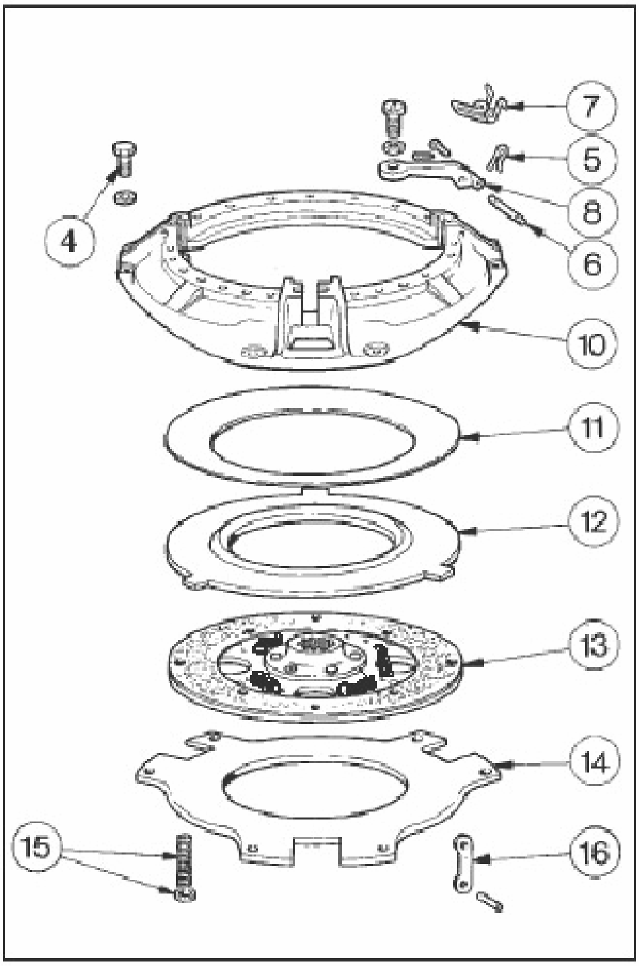


Fig 6

8. Disconnect the release levers from the links. (Item 8 in Fig. 6).
9. Slowly release the pressure from the press until the springs are out of compression.
10. Lift of the cover plate. (Item 10 in Fig. 6).
11. Lift off the Belleville spring. (Item 11 in Fig. 6).
12. Lift off the PTO pressure plate.
13. Lift off the PTO friction disc. (Item 13 in Fig. 6).
14. Lift off the false flywheel. (Item 12 in Fig. 6).
15. Remove the springs and the fiber washers (Item 15 in fig 6).
16. Remove the links.

Examination

Inspect all components for wear, scoring, distortion, cracks, or signs of overheating. Check condition of the Belleville springs.

Flywheel reclamation

If the flywheel is scored, skimming is permissible in 0.010 inch (0.254 mm) increments up to a maximum of 0.039 inch (1.00 mm).

The edge to which the clutch cover is bolted must be skimmed by the same amount to maintain the distance from the clutch face to 1.564 to 1.559 inch (39.75 to 39.62 mm) .

NOTE : *Never, under any circumstances, skim either the false flywheel or the pressure plates as this will severely impair their heat dissipation characteristics.*

Re-assembly

For reassembly follow the reverse procedures given above except,

Fit new springs and fibre washers to the pressure plate as shown in chart

Model	Number of springs	color	Illustration
MF 2605 (2WD and 4WD)	6	Post office Red	A
MF 2615 (2WD and 4WD)	9	Post office Red	B

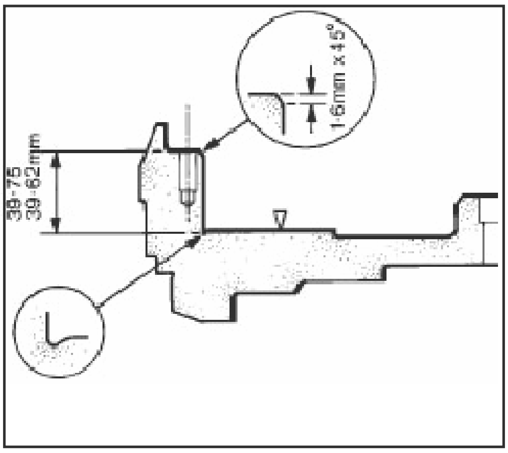
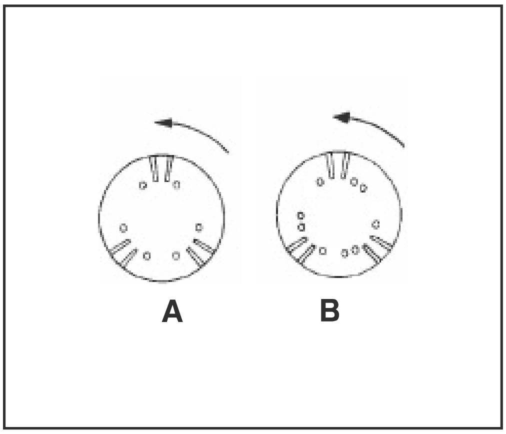


Fig 7



8A. 6 CLUTCH RELEASE BEARING

Removal and Refitment

Special Tool

SER / 054 : Tractor splitting stand

Removal

1. Split the tractor between the engine and transmission.
2. Release the two springs. (Item 1 in Fig. 8).
3. Remove the bearing and carrier assembly. (Item 2 in Fig. 8).
4. Drive out the bearing from the carrier. (Item 3 in Fig. 8).

Refitment

For refitment follow the reverse procedures given above and

1. Press a new bearing onto the carrier.
2. Lightly smear the input shaft splines and the release bearing carrier bore recess with recommended greases.
2. Remove the clutch assembly.
3. Drive out the flywheel pilot bearing from the bearing housing.

8A - 7 CLUTCH RELEASE MECHANISM

Removal and refitment

Removal

1. Split the tractor between the engine and gearbox, see section 4.
2. Remove the two springs.
3. Slide the carrier and release bearing off the input housing.
4. Remove the locking wire and the two locking screws from the release fork.
5. Slacken off the clamp bolt on the clutch pedal lever.
6. Remove the clutch pedal lever.
7. Withdraw the left-hand clutch half shaft from the gearbox casing.
8. Position a suitable drift, through the left-hand clutch shaft bore and carefully drive out the right-hand clutch half shaft.
9. Remove the clutch release fork.
10. Press the release bearing off the carrier.

Refitment

11. Reverse procedures 1 to 10 except:

    a. Lubricate the input shaft splines, release bearing carrier bore and release shaft bearings with one of the greases recommended in the specifications section on page 8A - 3.

    b. Ensure that the locking screws are located in the holes in the cross shaft.

    c. Adjust the clutch pedal clearance, see operation 8A . 3.

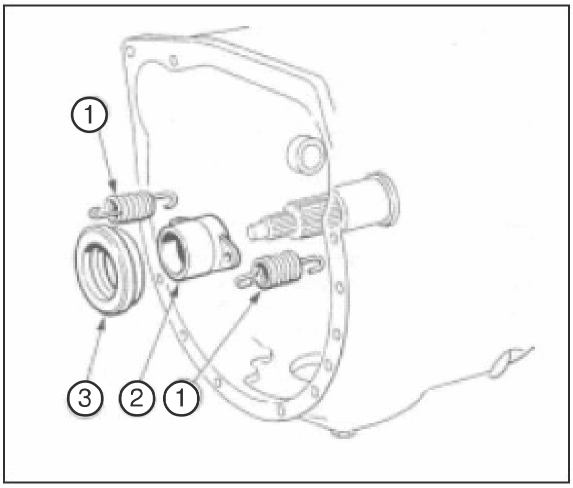


Fig 8

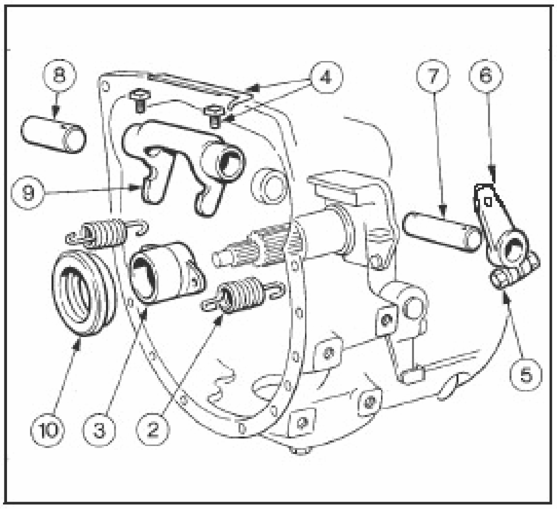


Fig 9

8 A - 8 FLYWHEEL PILOT BEARING

Removal and Refitment

Removal

1. Remove the clutch assembly, see 8B.2 or 8A.5
2. Remove the six bolts and washers.
3. Remove the flywheel.
4. Fill the pilot bearing bore with heavy grease, then insert a suitable length of 0.665 inch (16.9 mm) diameter rod into the pilot bearing bore. Tap the rod sharply to hydraulically eject the bearing.

Refitment

5. Fit a new pilot bearing.
6. Locate the flywheel, aligning the untapped hole in the flange to the unused hole in the flywheel.
7. Fit the flywheel bolts and washers then torque to 100 Nm (74 lbf.ft).
8. Refit the clutch.

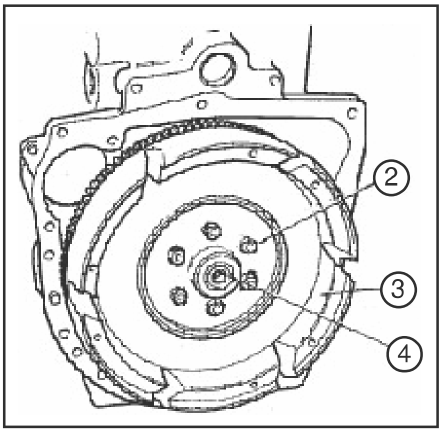


Fig 10

8.A.9 FAULT FINDING :

Symptom	Cause	Remedy
Improper Clutch Function	Oil or grease on friction plate.	Install new friction plate.
	Improper pedal adjustment.	Adjust clutch pedal free travel.
	Damaged pressure plate on clutch cover.	Replace defective part.
	Friction plate hub binding on splined drive pinion.	Clean up splines and smear with small quantity of recommended grease.
	Distorted friction plate.Broken facings on friction plate.	Install new friction plate.
	Dirt or foreign matter in the clutch.	Remove clutch from flywheel and clean with dry rag. See that all working parts are free.
	Rust formation on the clutch / Flywheel interface	Separate transmission case and engine. Clean clutch and flywheel face and assemble.
Clutch slip	Oil or grease on friction plate.	Install new friction plate.
	Weak or soft pressure springs.	Install new pressure springs.
	Bindings or clutch pedal mechanism preventing its full return to stop.	Free bearings. (NOTE : The clutch shaft bearings in the transmission case are self-lubricating. Oil or grease should not be applied).
	Improper pedal adjustment Preventing full engagement.	Adjust clutch pedal free play
	Clutch facing worn.	Install new friction plate.

SECTION 8

Clutch

INDEX

PART B

8B SPLIT TORQUE CLUTCH

Part B

Split torque Clutch

Table of Contents

Operation No.	Description			Page No.
8B.1	Specification	...	...	8B - 3
8B.2	General Description	...	...	8B - 4
8B.3	Split torque Clutch Assembly	...	...	8B - 5
8B.4	Split torque clutch over hauling	...	...	8B - 6
8B.5	Fly wheel pilot bearing	...	...	8B - 8

8B. 1Specification:

Clutch diameter - primary plate	...	12 inch (305 mm)
Clutch disc thickness - primary plate	...	0.362 inch (9.22 mm)
Clutch disc thickness - wear tolerance	...	0.098 inch (2.50 mm)
Release lever height - 12 inch (305 mm) clutch	...	3.24 - 3.25 inch (82.31-82.55 mm).
No.of springs	...	6 springs for MF 2605.
	...	9 springs for MF 2615.

Special Tools:

SER / 011	...	Clutch centraliser.
SER / 006	...	Lever height setting gauge.

Bolt Torques:

Clutch cover to flywheel (305 mm)	...	22 lbf.ft (30 Nm)
Flywheel to engine	...	74 lbf.ft (100 Nm)
PTO drive plate to clutch cover	...	27 lbf.ft (37 Nm)

8B.2GENERAL DESCRIPTION:

Split-torque Clutch - 305 mm:

The split torque clutch differs from the dual clutch in that the drive to the Ferguson linkage pump and Power Take- Off (PTO) is taken from the clutch cover and is always engaged when the engine is running. The clutch is therefore fitted to tractors with Independent Power Take- Off (IPTO) which employs a separate hydraulic clutch to engage or disengage the PTO.

The drive to the gearbox and rear wheels is transmitted from either a 305 mm driven plate.The friction disc (10) is operated by the pressure plate (9) against the flywheel. Pressure plate movement is obtained by three release levers (5), pivoted on the clutch cover plate (13). Release lever movement operating against the Nine coil springs (12) moves the pressure plate (9) rearwards and releases the friction disc (10). The clutch release levers (5) are operated by a release bearing (15) which is moved by the clutch pedal.

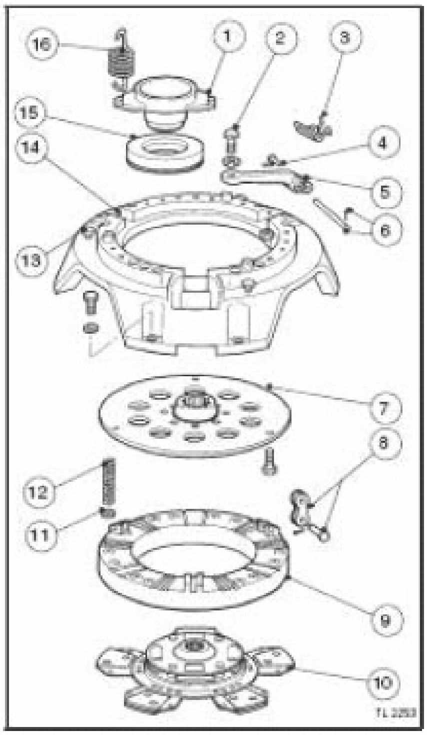


Fig 1

1. Carrier
2. Screw
3. Spring
4. Retaining clip
5. Lever
6. Pin
7. PTO plate
8. Link
9. Pressure plate
10. Fricition disc
11. Washer
12. Springs
13. Cover plate
14. Bolt
15. Bearing
16. Spring

8B.3 SPLIT-TORQUE CLUTCH ASSEMBLY

Removal and Refitment

Special Tools:

SER / 011 Clutch centraliser

SER / 006 Lever height setting gauge

WARNING:The following sequence of instructions must be followed carefully, as spring pressure will cause the clutch cover to fly apart if pressure is not released slowly and evenly.

Removal

1. Split the tractor between the engine and the gearbox .
2. Fit three slave bolts 1/4 UNC x 2 1/8 inch long to the three equally-spaced holes in the clutch cover.
3. Progressively slacken and remove the six bolts and washers.
4. Lift the clutch assembly clear of the flywheel. The main friction disc will remain separate from clutch assembly.

WARNING: Use a face mask when cleaning the clutch and housing. DO NOT USE COMPRESSED AIR.

Refitment

5. Lightly smear the splines of the friction disc with one of the greases recommended in the specifications in section 8A.1.
6. Locate the main friction disc in the flywheel.
7. Position the clutch assembly onto the flywheel.
8. Using SER / 011, centralise the clutch assembly and the friction disc.
9. Refit the six bolts and washers. Torque to 22 lbf.ft (30 Nm).
10. Remove the three slave bolts and then remove SER / 011.
11. Using tool number SER / 006 lever height setting gauge, check the adjustment of each release lever. The domed end of the release lever setscrew must be just touching the gauge. Adjust the setscrews as required and re-tighten the locknuts.
12. Reassemble the tractor.
13. Adjust the clutch pedal free travel, see operation 8A.3

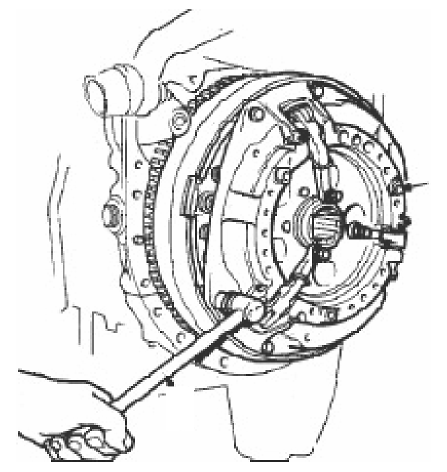


Fig 2

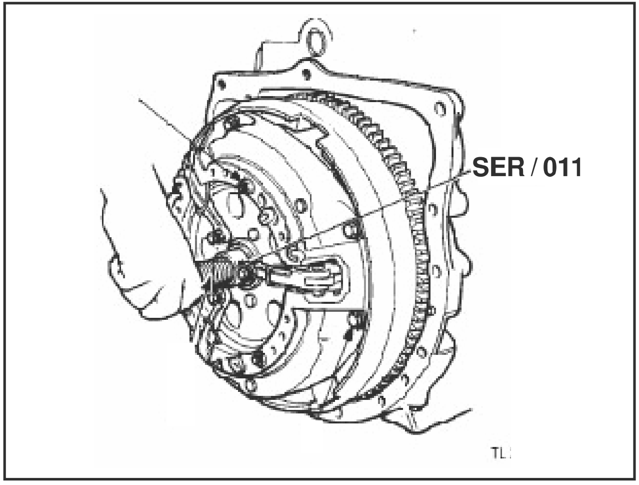


Fig 3

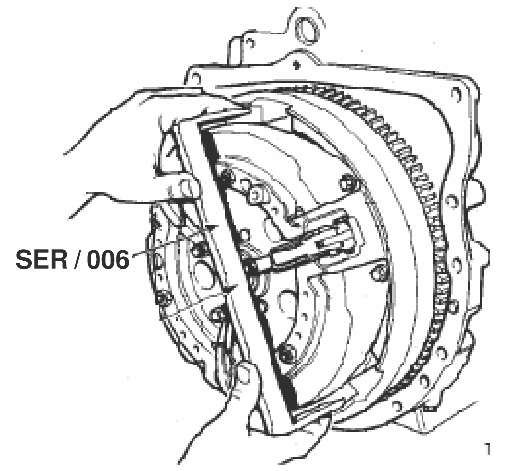


Fig 4

8B. 4 SPLIT-TORQUE CLUTCH :

Overhaul

Specia Tools:

SER / 011 Clutch centraliser

SER / 006 Lever height setting gauge Hydraulic press.

Dis-assembly

1. Remove the clutch assembly, see operation 8B.2
2. Place the clutch assembly on the hydraulic press and locate a suitable bar across the top of the clutch cover.

WARNING: Ensure that the clutch is located under the press correctly, that the bar will not slip and that the press has sufficient travel to allow the spring pressure to come off. Release the pressure evenly and slowly.

3. Apply pressure until the three 1/4 inch slave bolts can be easily removed.
4. Removing the retaining clips from the pivot pins.
5. Remove the pivot pins.
6. Remove the lever springs.
7. Disconnect the release levers from the links.
8. Slowly release the pressure from the press until the springs are out of compression.
9. Lift off the cover plate assembly.
10. Remove the springs and the fiber washers.
11. Remove the links.
12. Remove the three bolts and nuts.
13. Remove the PTO plate.

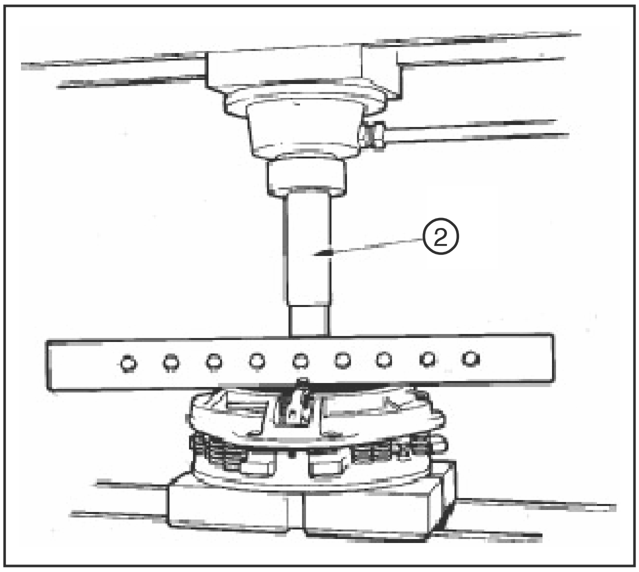


Fig 5

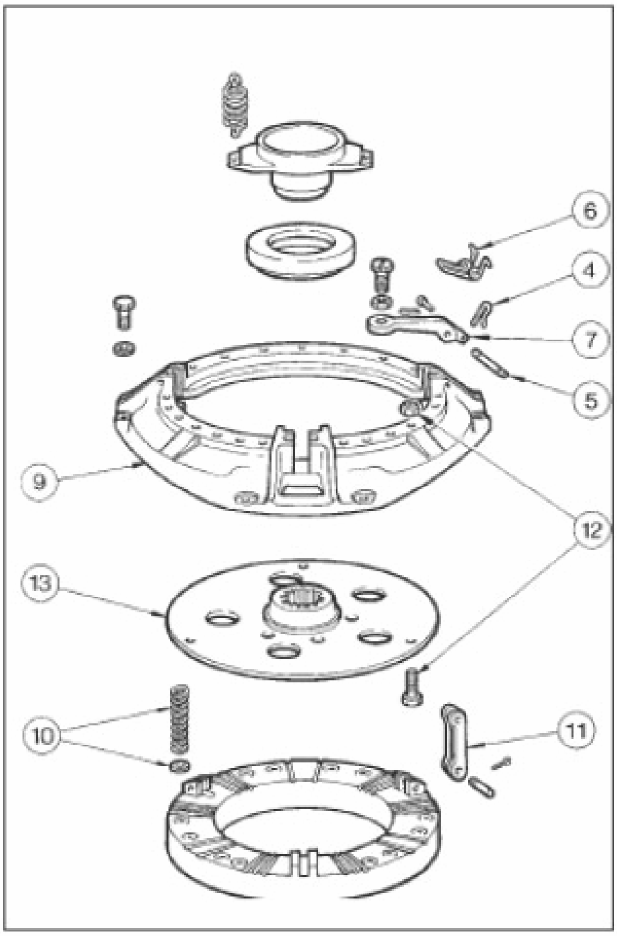


Fig 6

Examination

Inspect all components for wear, scoring, cracks, distortion or signs of overheating.

If the tractor flywheel is scored, skimming is possible, in 0.010 inch (0.254 mm) increments up to a maximum of 0.0393 inch (1.00 mm).

The ledge to which the clutch cover is bolted must be skimmed by the same amount to maintain the distance from the clutch face of 1.564 to 1.559 inch (39.75 to 39.62 mm) - see fig 7

NOTE: *Never, under any circumstances, skim the pressure plate, as this will severely impair its heat dissipation characteristics.*

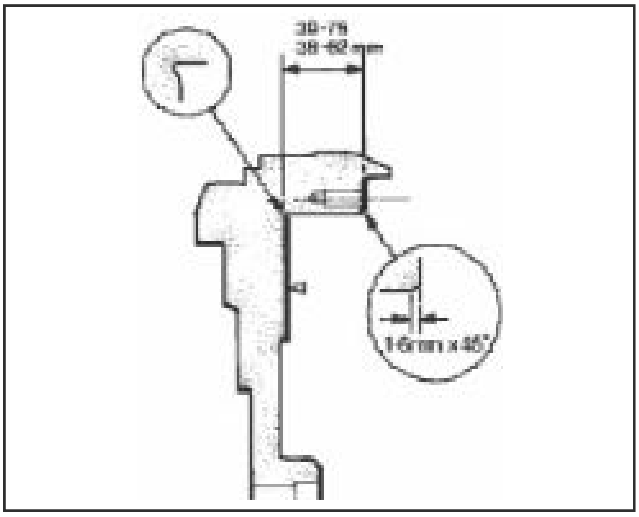


Fig 7

Re-assembly

14. Reverse procedures 1 to 13 except:
    (a) Fit nine new springs and fiber washers to the pressure plate in the positions shown in the illustration - see fig 8.
    (b) Refit the PTO plate (13) and torque the bolts to 27 lbf.ft (37 Nm).

Model	Number of springs	color	Illustration
MF 2605 (2WD and 4WD)	6	Post office Red	A
MF 2615 (2WD and 4WD)	9	Post office Red	B

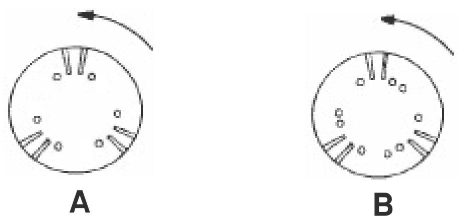


Fig 8

8B . 5 FLYWHEEL PILOT BEARING

Removal and Refitment

Removal

1. Remove the clutch assembly, see 8B.2 or 8A.5
2. Remove the six bolts and washers.
3. Remove the flywheel.
4. Fill the pilot bearing bore with heavy grease, then insert a suitable length of 0.665 inch (16.9 mm) diameter rod into the pilot bearing bore. Tap the rod sharply to hydraulically eject the bearing.

Refitment

5. Fit a new pilot bearing.
6. Locate the flywheel, aligning the untapped hole in the flange to the unused hole in the flywheel.
7. Fit the flywheel bolts and washers then torque to 74 lbf.ft (100 Nm).
8. Refit the clutch.

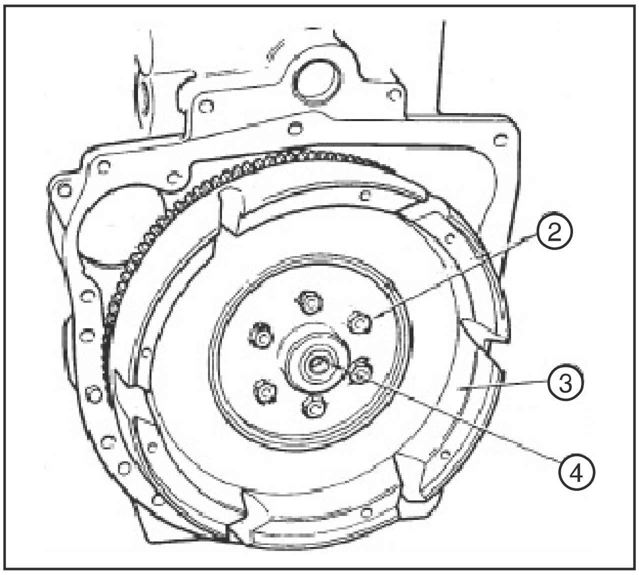


Fig 9

SECTION 9

Transmission

INDEX

Part A

9A 8 SPEED TRANSMISSION – DUAL CLUTCH

Part A

8 Speed Transmission – Dual Clutch
Table of Contents

Operation No.	Description	Page No.
9A.1	Specification … …	9A - 3
9A.2	General Description - Center shift … …	9A - 4
9A.3	General Description - Side shift … …	9A - 5
9A.4	Gear Shift Levers - Center shift … …	9A - 7
9A.5	Gear Shift Levers - Side shift … …	9A - 8
9A.6	Selector Rails and Forks - Center shift …	9A - 27
9A.7	Selector Rails and Forks - Side shift …	9A - 28
9A.8	Epicyclic Unit - Center shift … …	9A - 29
9A.9	Epicyclic Unit - Center shift … …	9A - 30
9A.10	Clutch Release Mechanism … …	9A - 31
9A.11	Main Drive Housing and PTO Pinion Shaft …	9A - 32
9A.12	PTO Drive Shaft Bearing Housing …	9A - 34
9A.13	Main Shaft, Counter Shaft and Gears …	9A - 35
9A.14	Side shift service tool details …	9A - 38

9A.1 SPECIFICATION

Type : Sliding mesh, manual center Shift & manual Side shift

No. of gears forward : 8

No.of gears reverse : 2

Epicyclic reduction unit type : Normal duty

Reduction : 4 : 1

Special Tools

SER / 054 : Tractor splitting stand.

SER / 076 : Input shaft oil seal replacer.

SER / 075 : Housing main drive needle bearing remover and replacer.

SER / 036 : PTO pinion oil seal replacer.

SER / 038 : Hand press tool

SER / 056 : Adaptor for multipurpose bearing remover / replacer

SER / 099 : Oil seal replacer

SER / 087 : Reverse gear cluster bearing fitter

SER3000007 : Side shift & high /low service tool

Torque Values

Steering wheel nut : 35 lbf. ft. (47 Nm)

Cover plate to transmission case : 60 lbf. ft. (81 Nm)

Shifter fork locking screws : 32 lbf. ft. (43 Nm)

Epicyclic unit to transmission case : 35 lbf. ft. (47 Nm)

Inter lock mechanism to transmission case : 32lbf. ft. (43 Nm)

Housing main drive to transmission case : 45 lbf. ft. (61 Nm)

Housing front PTO to transmission case : 45 lbf. ft. (61 Nm)

Engine to transmission case : 50 – 57 lbf. ft. (68 – 77 Nm)

Transmission case to rear transmission : 83 lbf. ft. (112 Nm)

9A.2 GENERAL DESCRIPTION - CENTER SHIFT

The main transmission has four forward speeds and one reverse, doubled by an epicyclic reduction unit to give eight forward speeds and two reverse

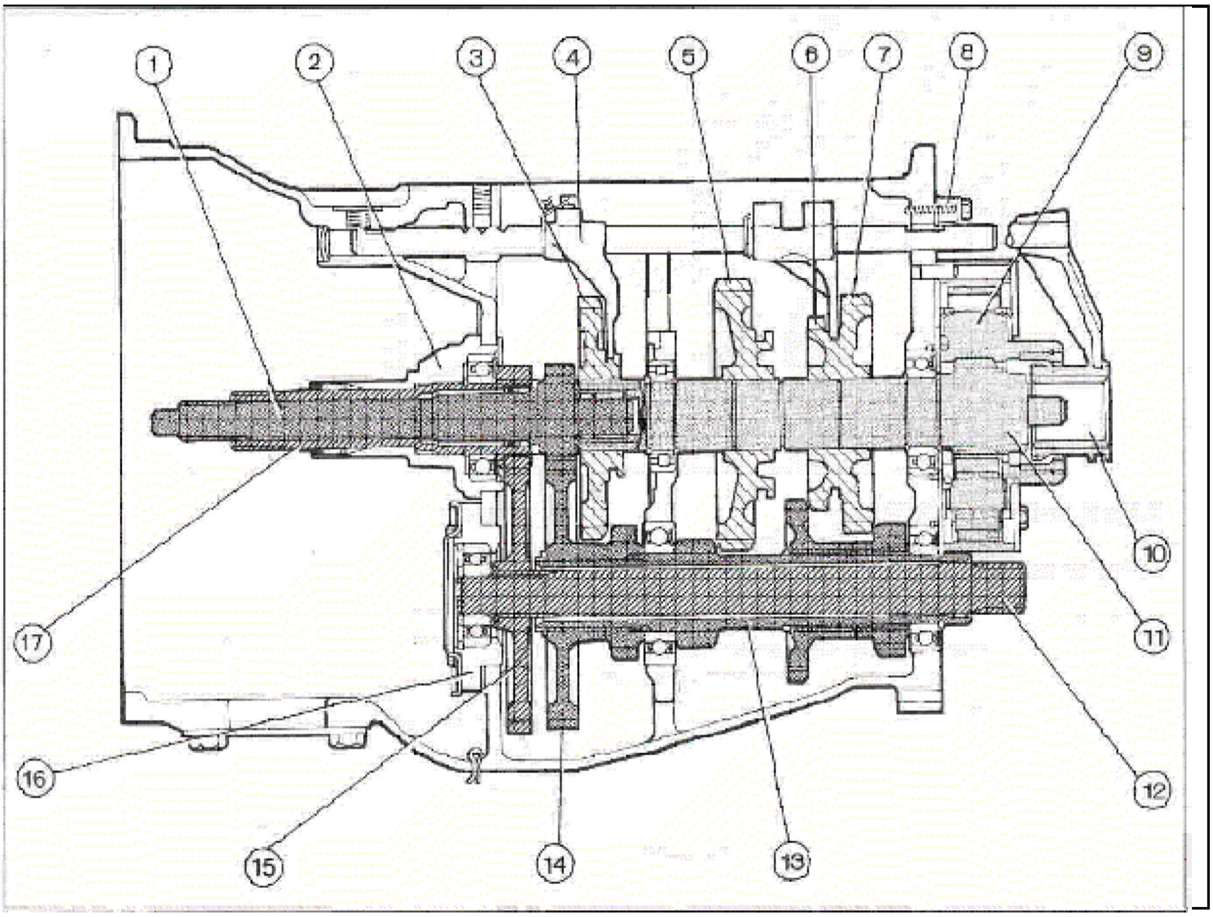


Fig. 1

1. Input shaft
2. Input shaft housing
3. Third gear
4. Selector rails and forks
5. First and reverse gear
6. Fourth gear
7. Second gear
8. Gear shift interlock
9. Epicyclic reduction unit
10. Coupler
11. Mainshaft
12. PTO drive shaft
13. Hollow counter shaft
14. Constant mesh gear
15. Constant mesh gear (PTO)
16. PTO front bearing housing
17. PTO input shaft and gear

9A.3 GENERAL DESCRIPTION - SIDE SHIFT

The main transmission has four forward speeds and one reverse, doubled by an epicyclic reduction unit to give eight forward speeds and two reverse

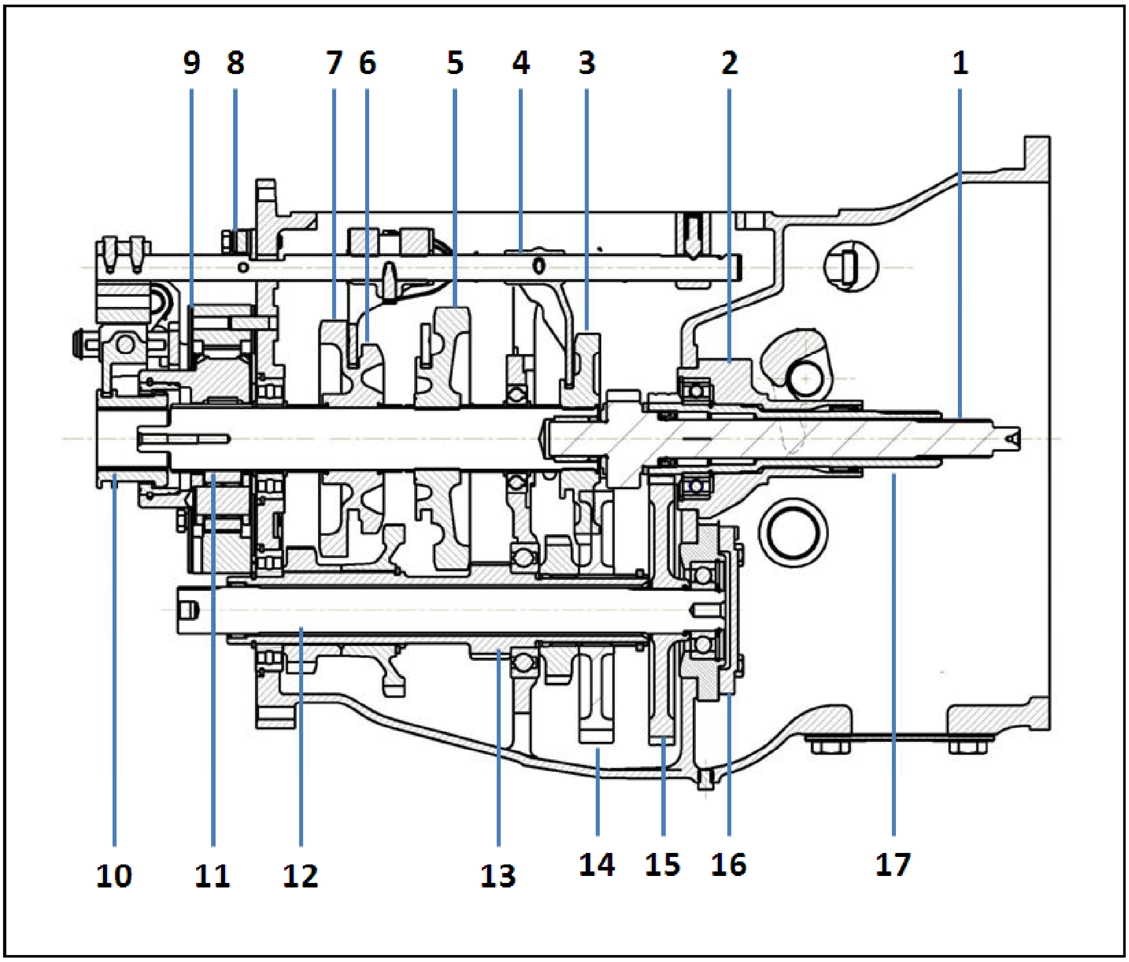


Fig. 2

1.	Input shaft
2.	Input shaft housing
3.	Third gear
4.	Selector rails and forks
5.	First and reverse gear
6.	Fourth gear
7.	Second gear
8.	Gear shift interlock
9.	Epicyclic reduction unit
10.	Coupler
11.	Mainshaft
12.	PTO drive shaft
13.	Hollow counter shaft
14.	Constant mesh gear
15.	Constant mesh gear (PTO)
16.	PTO front bearing housing
17.	PTO input shaft and gear

Main Transmission Drive

The input shaft is driven by the main transmission clutch plate and drives a pair of constant mesh gears. These, in turn, drive a hollow counter shaft to which are attached the first, second, third and fourth ratio gears. The mainshaft is located above the counter shaft and has mounted on it three sliding gears, one of which is a compound gear having two sets of teeth.

The sliding gears are operated by selector forks mounted on shifter rails which in turn are operated by the gear selector lever located directly above the transmission case.

The sliding gears mesh with the counter shaft gears to give, from the front, third, first, fourth and second gears respectively depending upon the gear selected by the lever.

Epicyclic Reduction Unit

The epicyclic unit consists of a ring gear and three planetary pinions. It is mounted on the rear of the transmission case and driven by the mainshaft splined extension which acts as a sun gear.

To transmit the drive from the main transmission to the rear axle a drive shaft is connected by a coupler, either directly to the gearbox mainshaft (HIGH range) of the planetary pinion carrier where the speed of the gearbox is reduced by 4 : 1 (LOW range). The coupler is operated by a selector fork, rail and gear lever which is mounted alongside the main gear selector lever. As well as selecting either HIGH or LOW range, the lever also has a middle or neutral position which disengages the coupler splines from both the mainshaft and the planetary pinion carrier. In this neutral position an electrical switch completes the starting circuit and the danger of starting in gear is prevented.

Reverse Drive

Reverse drive is achieved by the engagement of a compound gear cluster mounted in the left-hand side of the transmission case. One of the gears is in constant mesh with the fourth gear pinion on the counter shaft. The other gear is engaged by the sliding first gear on the mainshaft. This combination reverses the rotation of the mainshaft, reduction unit and final drive.

PTO Drive Shaft

The PTO input shaft driven by the secondary plate on the dual clutch, rotates a pair of constant mesh gears. These, in turn, drive the PTO shaft which projects rearwards through the hollow counter shaft to drive the hydraulic pump and PTO.

9A.4 GEAR SHIFT LEVERS - CENTER SHIFT

Removal and Refitment

Removal

1. Remove the steering wheel, instrument panel, and other parts necessary to give access to the transmission case top and cover plate assembly.
2. Disconnect hydrostatic pipe lines to hydrostatic steering unit.
3. Remove the hydrostatic steering unit.
4. Remove the bolts securing the top cover assembly to the transmission case.
5. Remove the cover plate assembly from the tractor and place on a work bench.

Main Gear Lever

1. Remove the gear lever knob and nut.
2. Remove the bellow rubber boot and clips.
3. Turn the cover assembly over to facilitate the remove of the spring seat and spring. (Item 1 in Fig. 3)
4. Remove the gear shift lever retaining pin. (Item 4 in Fig. 3)
5. Loosen and remove the ring lock. (Item 3 in Fig. 3)
6. Remove the gear shift lever. (Item 5 in Fig. 3)
7. Tap out the gear shift lever cup. (Item 2 in Fig. 3)

High / low Gear Lever

1. Remove the gear lever knob and nut.
2. Remove the bellow rubber boot and clips.
3. Remove the gear shift lever retaining pin. (Item 3 in Fig. 4)
4. Loosen and remove the ring lock. (Item 2 in Fig. 4)
5. Remove the high/low gear lever. (Item 4 in Fig. 4)
6. Tap out the gear shift lever cup. (Item 1 in Fig. 4)

Refitment

For reassembling, follow the reverse procedures given above, and

1. Replace the bellow rubber covers to prevent water getting into the transmission.
2. Replace the gasket in between transmission and cover plate and torque to 60 lbf. ft. (81 Nm).
3. Replace the steering wheel and tighten the steering wheel nut to torque of 35 lbf. ft. (47 Nm).

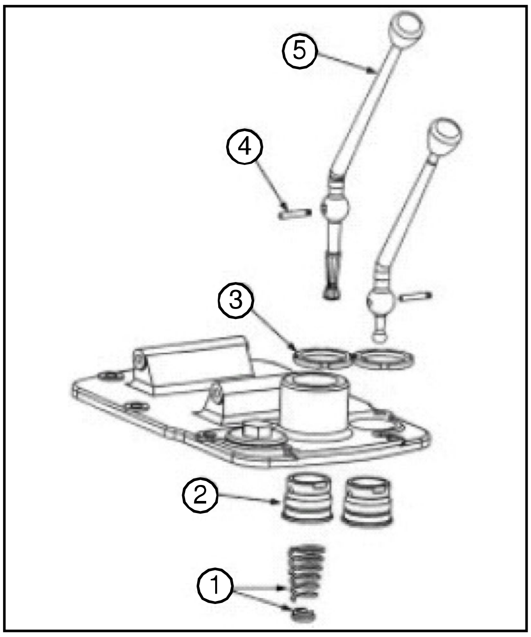


Fig. 3

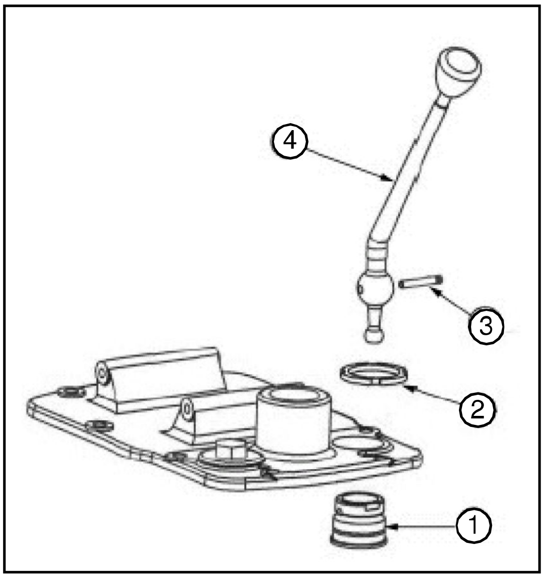


Fig. 4

9A.5 GEAR SHIFT LEVERS - SIDE SHIFT

Removal and refitment

Removal

1. Park the vehicle on level ground and apply parking brake.
2. Pull the hood latch cable and lift the hood.
3. Disconnect the battery terminals
4. Remove the platform from the tractor, see operation 5.16 Foot step (page 5A - 14).
5. Ensure the side shift lever in neutral position.
6. Remove the dipstick
7. Remove 4 bolts, 1 allen head screw and 1 nut in side shift cover
8. Remove M5 nut from side shiftcover
9. Disconnect the response lever by removing a cotter and a clevis pin.
10. Remove the side shift assembly from centre housing.
11. Keep the side shift assembly in suitable fixture.

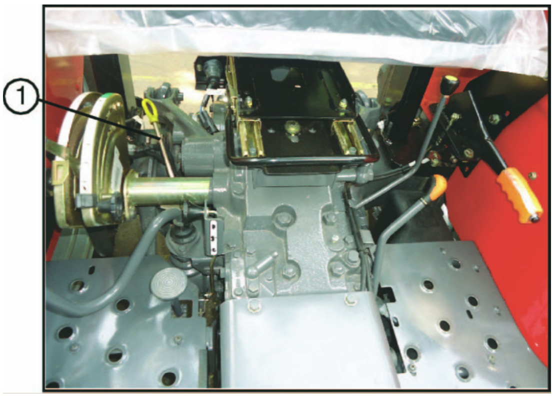


Fig 5

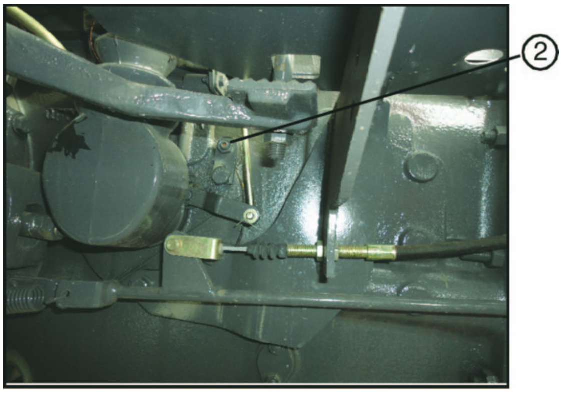


Fig 6

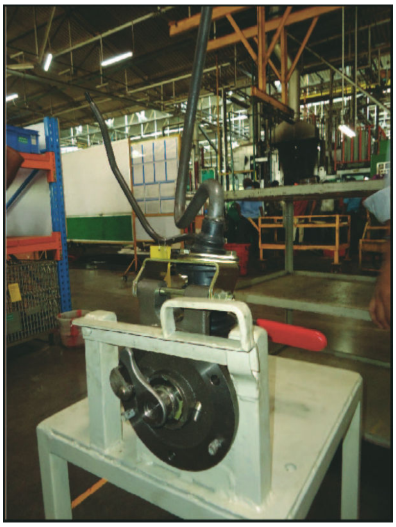


Fig 7

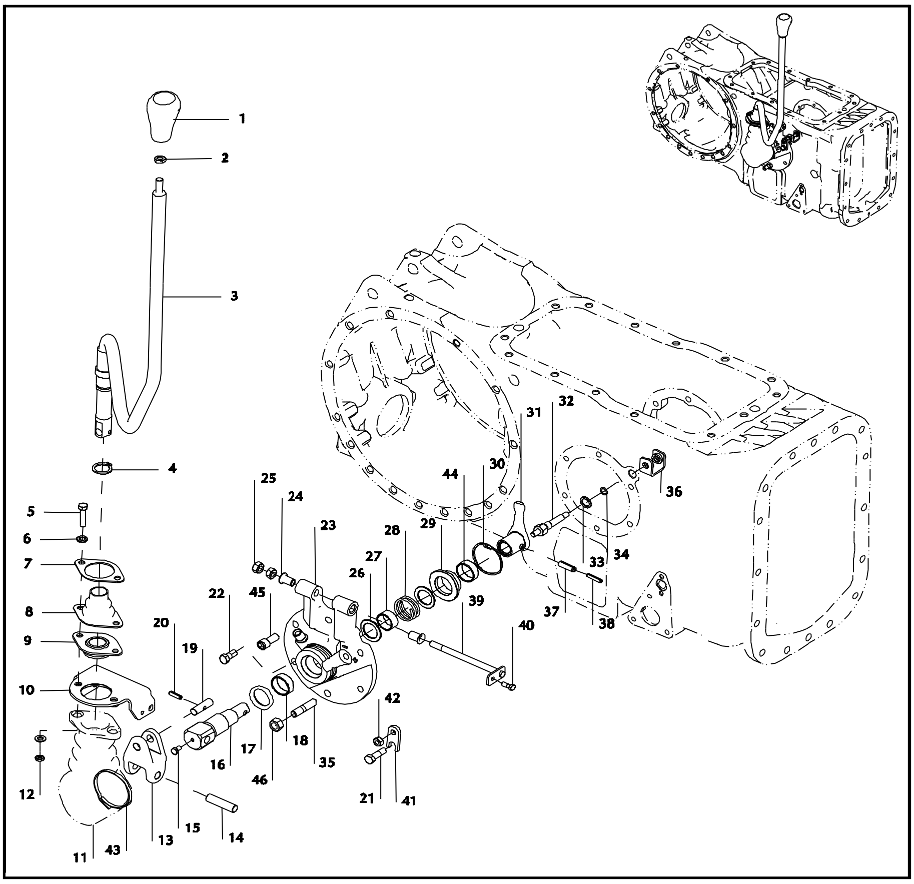

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Fig 8

Removal - side shift Gear lever

1. Remove knob(1) and M5 nut(2).
2. Remove the strap(43) and slightly lift the rubber boot(11) for easy accessability.
3. Remove the spring pin(20) and pin (19).
4. Remove the M5 nut(25),M6 bolt(40) and pin assy(39).
5. Remove circlip(4),bolt(5),washer(6),and nut(12).
6. Remove the plate(7),boot(8),assembly ball(9), pivot plate(10) and rubber boot(11).

Removal - side shift housing

7. Remove the M6 bolt(15) and pin (14).
8. Remove the spring pin(38)(37) and selector pawl(31).
9. Remove the shaft(16).
10. Remove the pin (5) and remove the cam (6) and spring (7) - Refer fig: 9.
11. Remove the pin (13) and remove the lever (15), shaft (12) and washer (11) - Refer fig:9.
12. Remove the circlip(30), bush(44) , collar(29), washer(26), spring(28) and spacer(27) .
13. Remove oil seal(17) and bush(18).

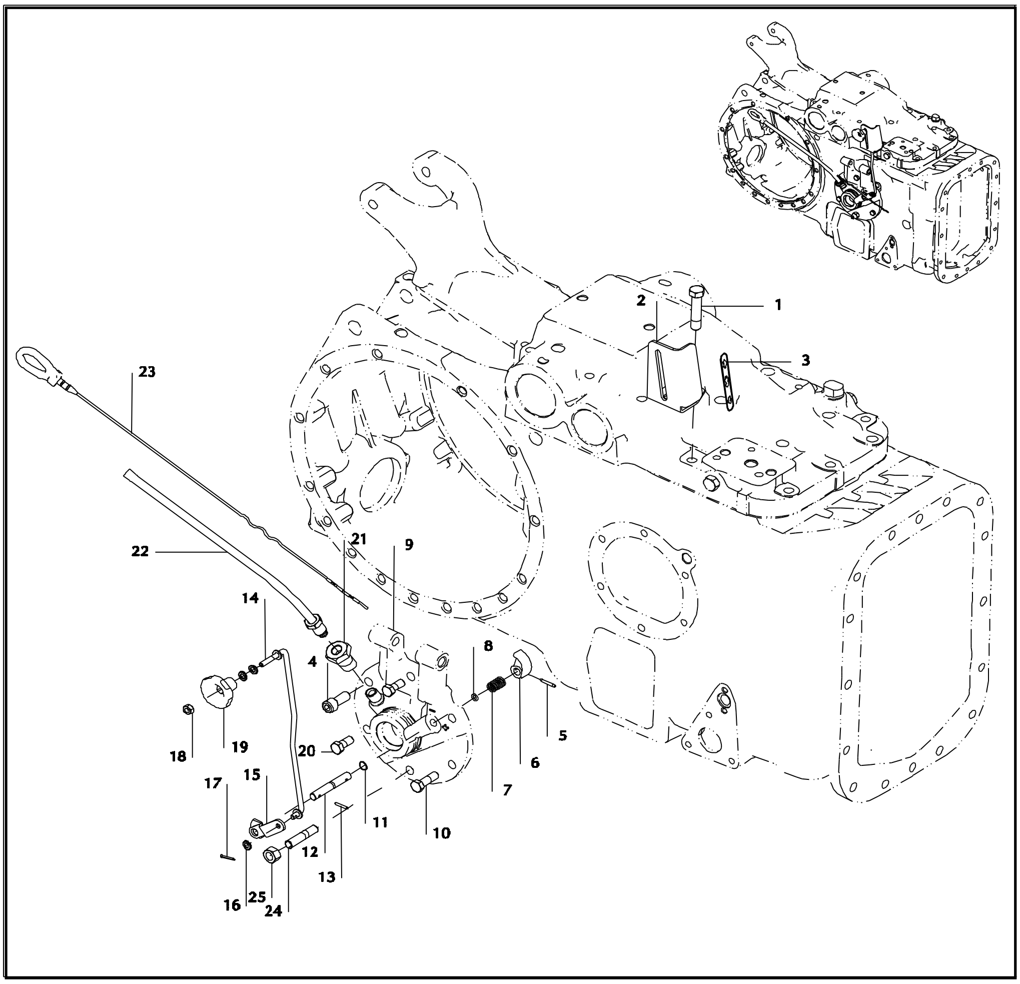
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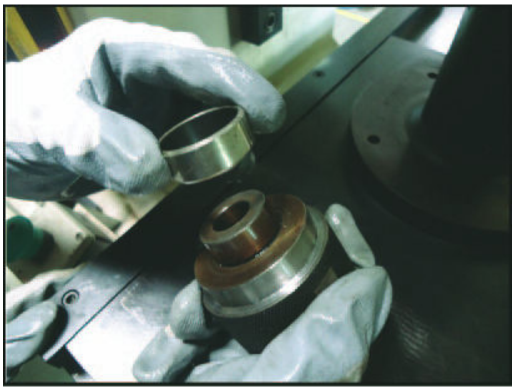
Fig 9

Refitment

1. Place the collar on the table

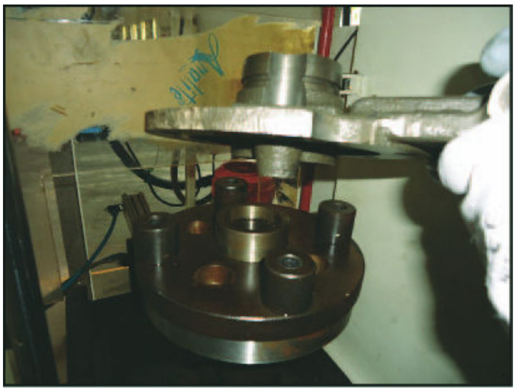
2. Place the bush in the service tool (SER3000007) as shown

NOTE : Refer page no:39 for service tool details



3. Press the bush inside the collar using a hand press

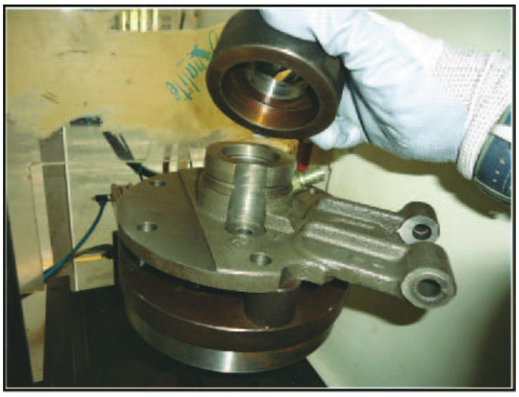
4. Place the side cover housing on a suitable work bench as shown



Refitment

5. Place the service tool (SER3000007) on the side cover housing as shown

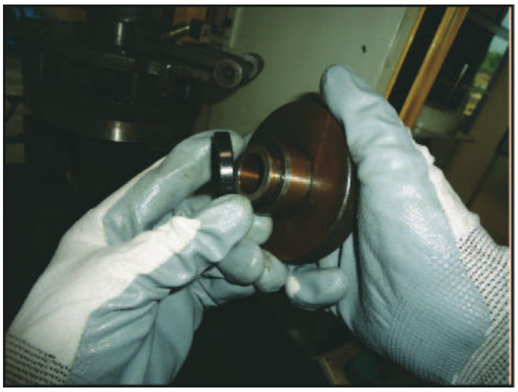
NOTE : Refer page no:39 for service tool details



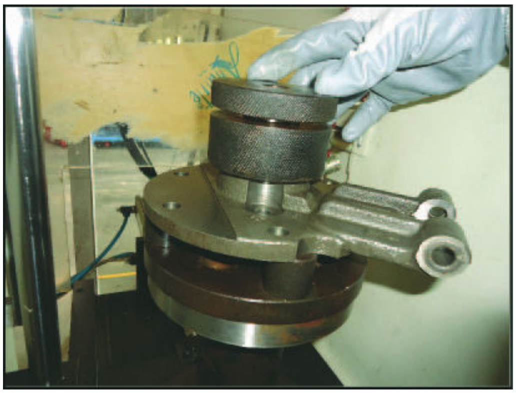
6. Fix the seal on the service tool (SER3000007)

NOTE: The lip of the seal to be faced up

Refer page no:39 for service tool details

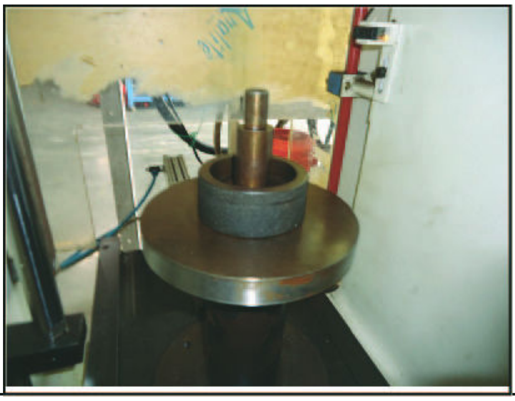


7. Place the seal on the side cover housing and press using a hand press



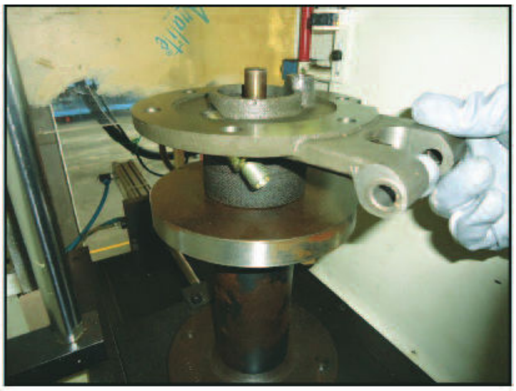
8. Place the service tool(SER3000007) on the work bench as shown

NOTE : Refer page no:39 for service tool details

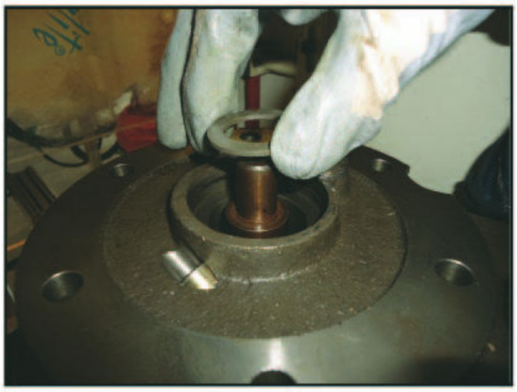


Refitment

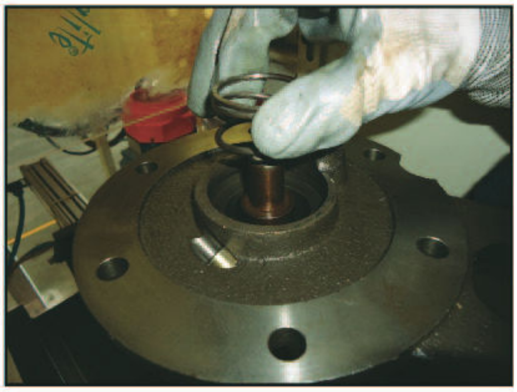
9. Place the side shift cover housing on the tool



10. Place the spacer inside the side cover housing

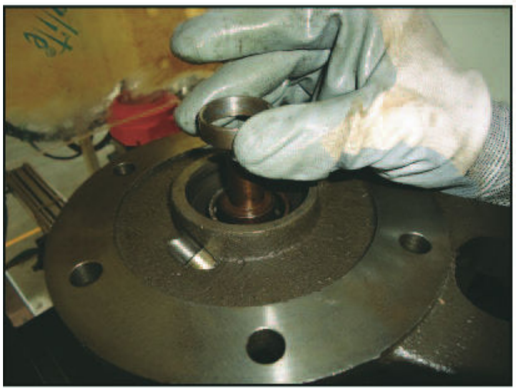


11. Place the spring



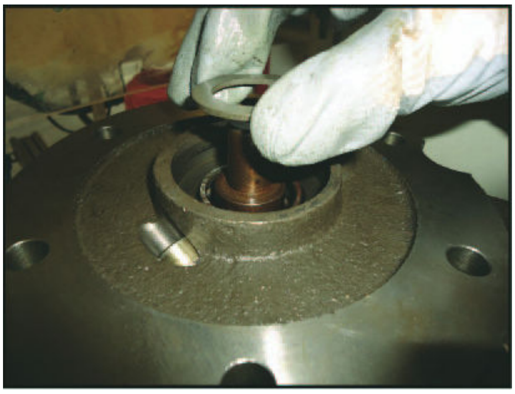
12. Place the collar

NOTE: The collar to be placed inside the spring



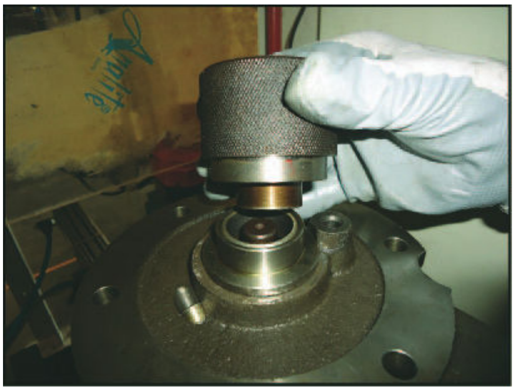
Refitment

13. Assemble the washer over the spring

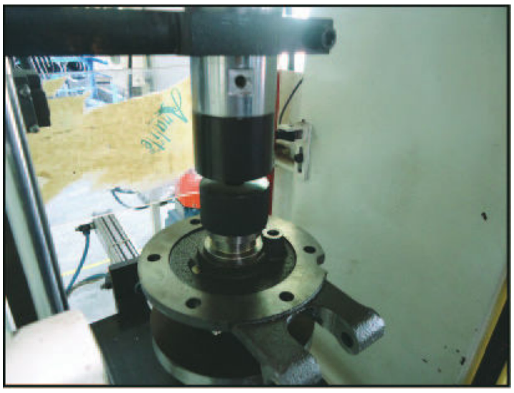


14. Assemble the bush on the side cover housing and place the service tool (SER3000007) as shown

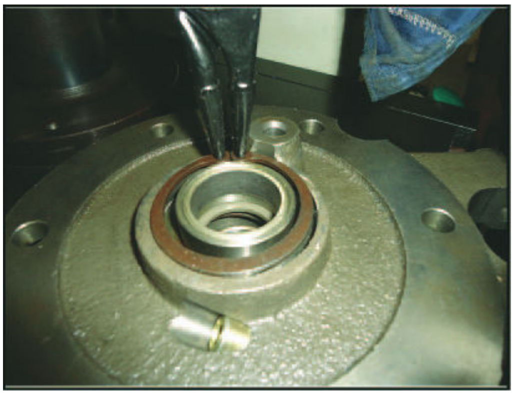
NOTE : Refer page no:39 for service tool details



15. Press the assembly using a hand press



16. Secure the assembly with circlip

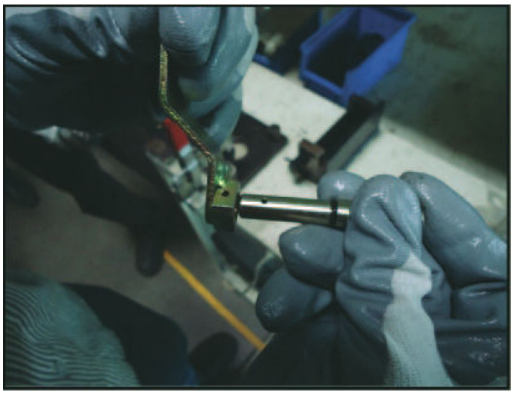


Refitment

17. Assemble the O ring on the repnse cover shaft

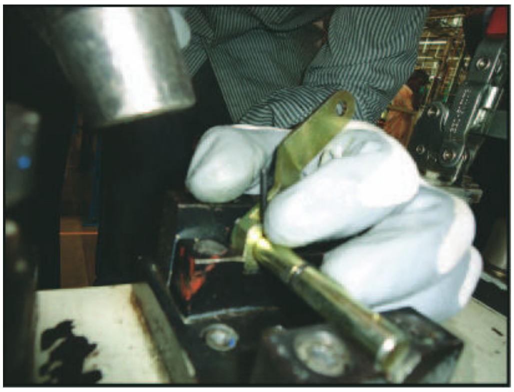
18. Assemble the response cover shaft with response lever

NOTE: Match the holes of response cover shaft and response lever



19. Place the assembly in a suitable vice

20. Secure the responsed cover shaft with response lever using a spirol pin

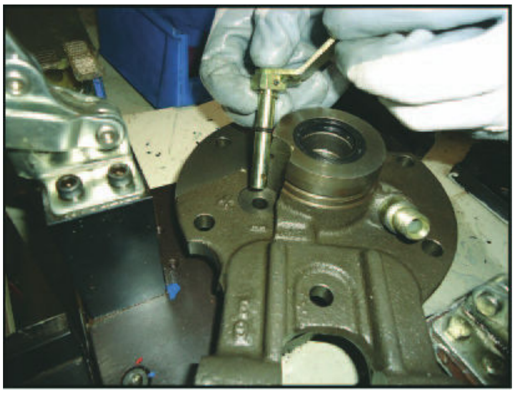


21. Assemble the ring with the response assembly

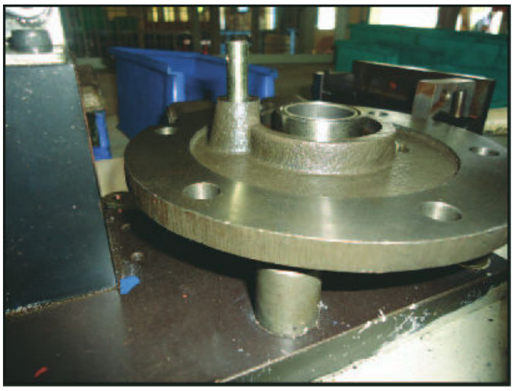
Refitment

22. Place the side cover housing in a suitable vice

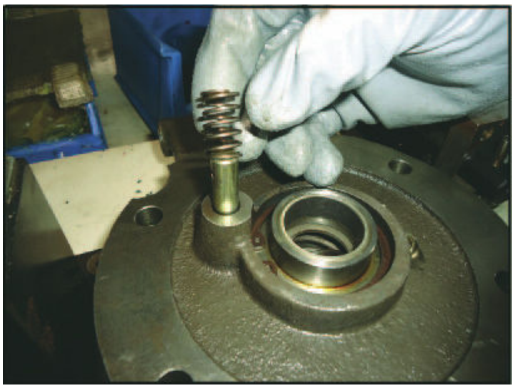
23. Assemble the resonse lever assembly with side cover housing and hammer using a mallet



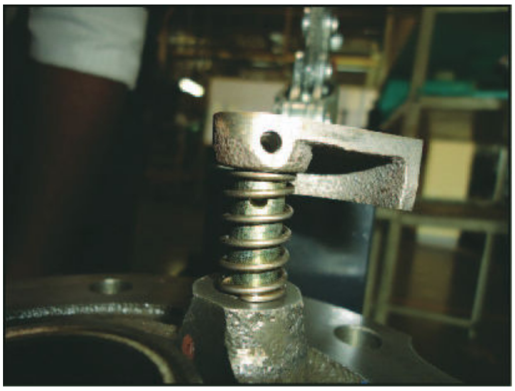
24. Turn the side cover housing and place in a suitable vice



25. Assemble the spring on the response cover shaft

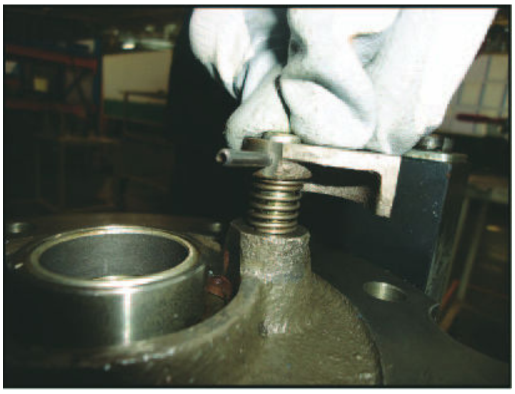


26. Assemble the cam on the response cover shaft

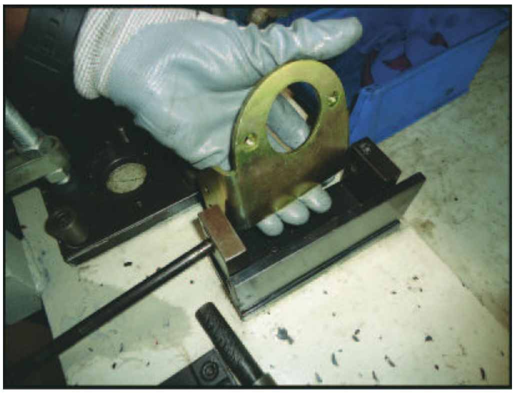


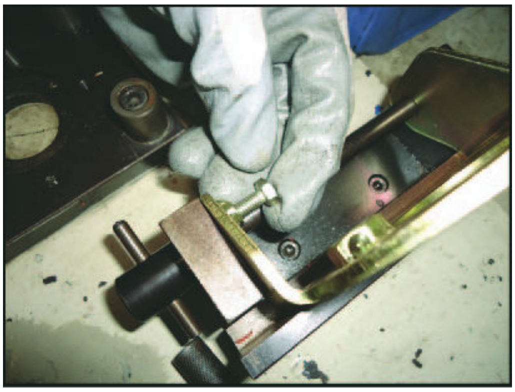
Refitment

27. Align the hole in the cam with hole in response cover shaft by applying little force on the cam
28. secure using a spirol pin

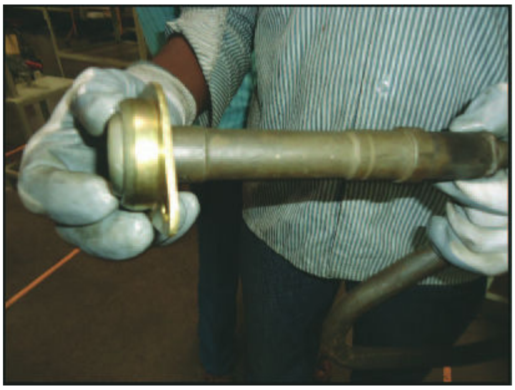


29. Place the pivot plate in a suitable vice and secure it properly



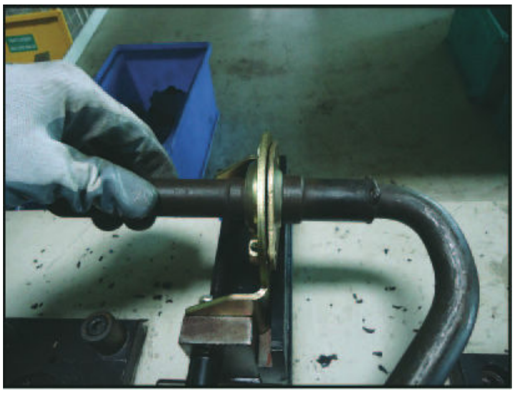


30. Assemble the ball & housing assembly with gear shift lever

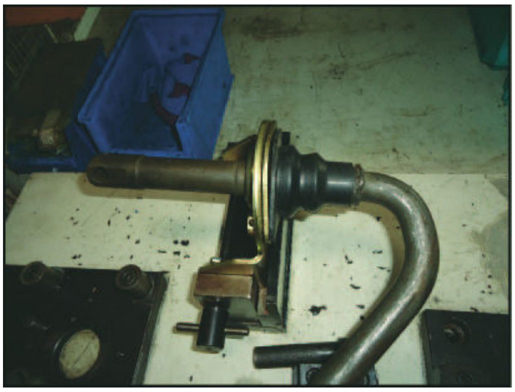


Refitment

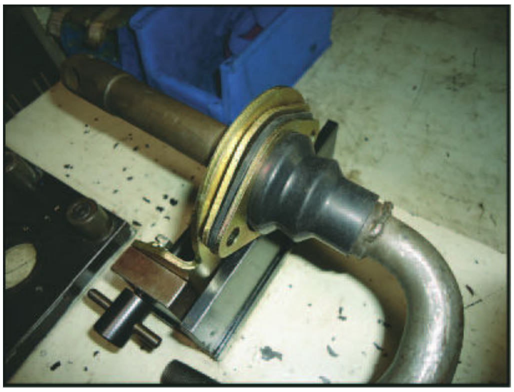
31. Assemble the gear shift lever with the pivot plate



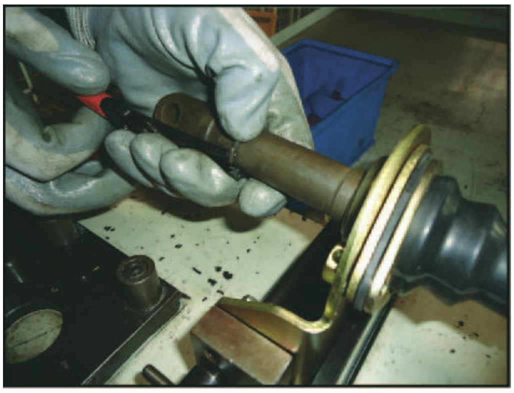
32. Assemble the rubber boot with the gear shift lever



33. Assemble the clamp plate with gear shift lever

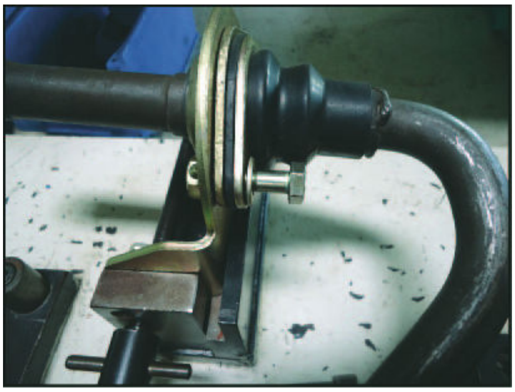


34. Secure the gear shift lever with pivot plate using a retaining ring.

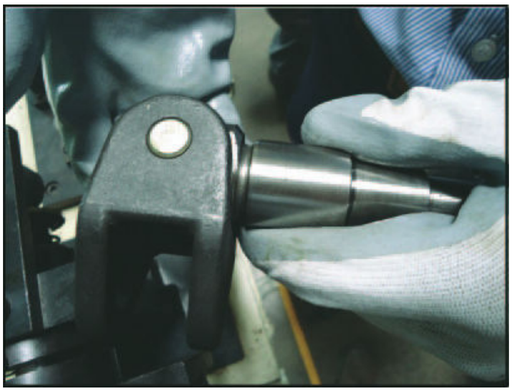


Refitment

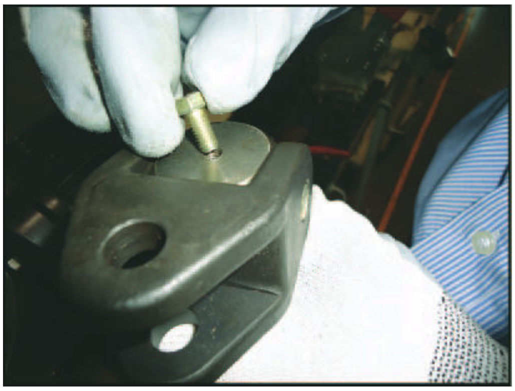
35. Secure the gear shift lever assembly with pivot plate using two bolts



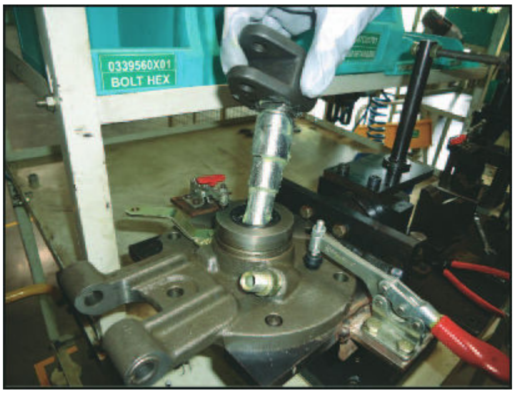
36. Align side shift with synchro pivot block and secure using a solid pin



37. secure the solid pin with a hex bolt



38. Place the side cover housing on a suitable vice
39. Apply grease on the side shift shaft
40. Position the side shift shaft assembly with the side cover housing



Refitment

41. Place the side cover housing on a suitable vice

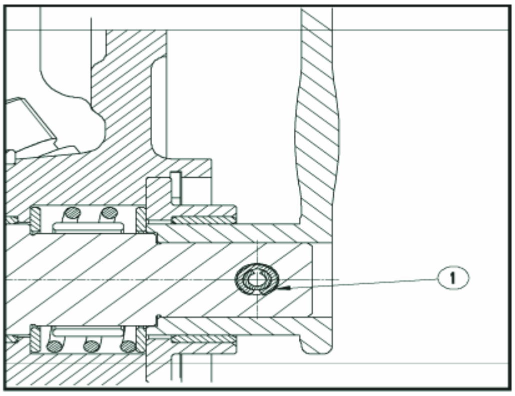
42. On the rear side of the side cover housing, assemble the selector pawl with the side shift shaft

43. Align the holes of selector pawl and side shift housing and secure using a spirol pin

44. Double secure the assembly with another spirol pin which have smaller diameter than the previous.

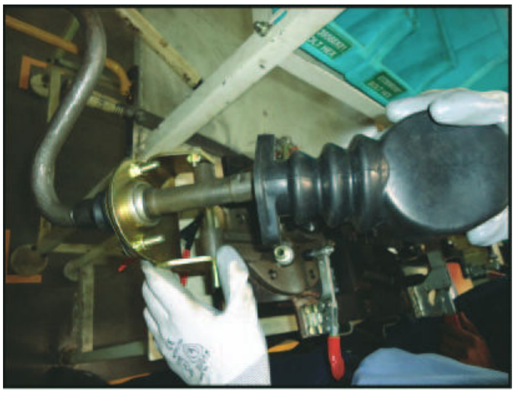
NOTE: Ends of the both spirol pin should be placed diametrically opposite to each other

45. Spring dowel to be assembled as shown

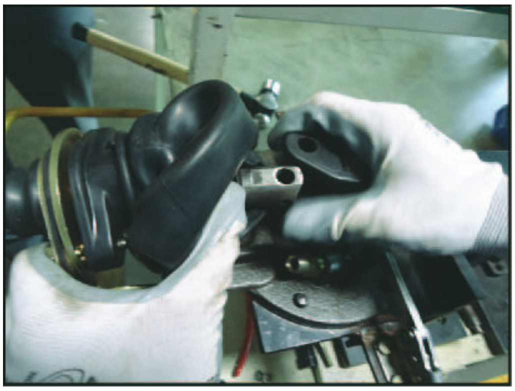


Refitment

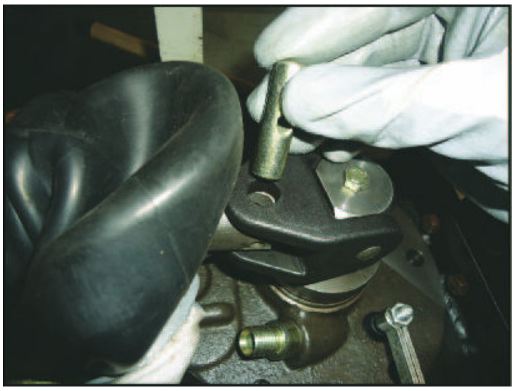
46. Assemble the rubber boot with gear shift lever assembly
47. Secure the assembly using bolt & nut



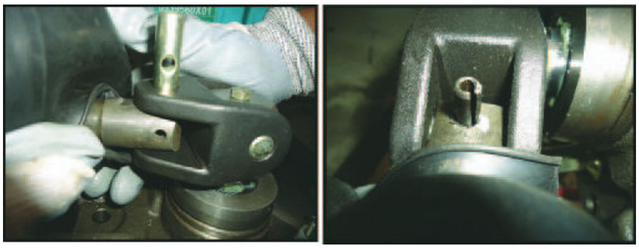
48. Assemble the gear shift assembly with side cover housing assembly by aligning the holes of gear shift lever and synchro block



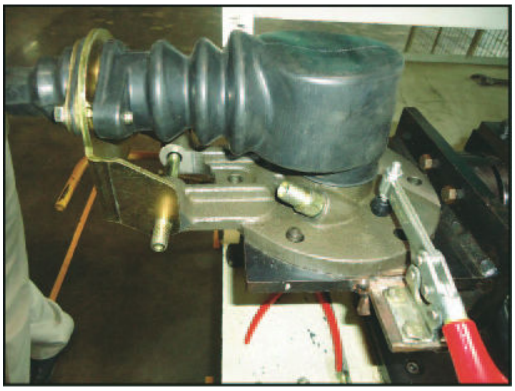
49. Secure using a solid pin



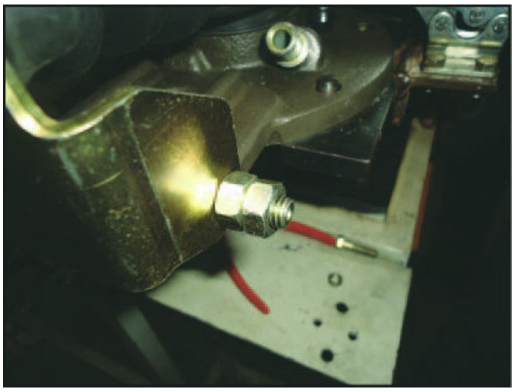
50. Align the hole of solid pin with gear shift lever and secure using a spirol pin

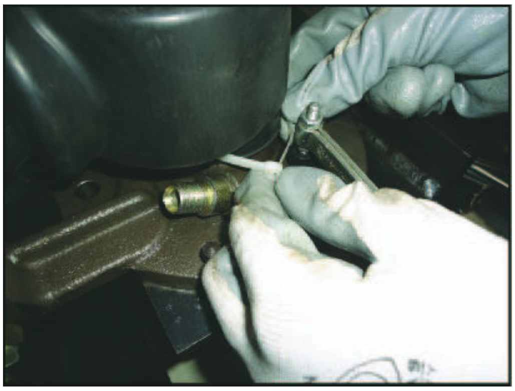


Refitment



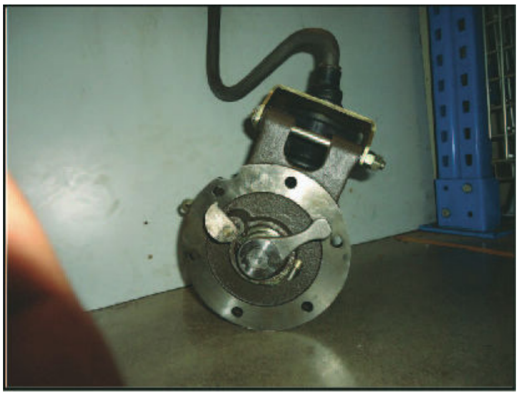
51. Fix the pivot plate with side cover housing using pin assembly
52. Secure with two bolts





53. Secure the rubber boot using a plastic strap
54. Tighten all the fastners

55. Assemble the Side shift sub assembly to the tractor



PLANETARY LEVER (HIGH-LOW GEAR LEVER)

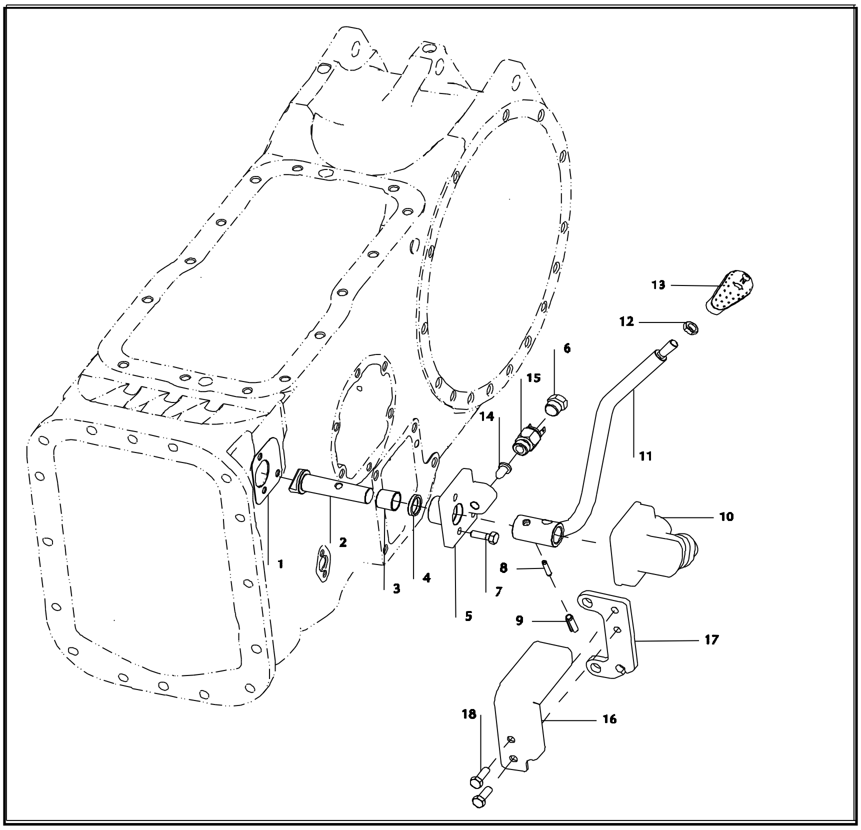


Fig 10

Removal and refitment

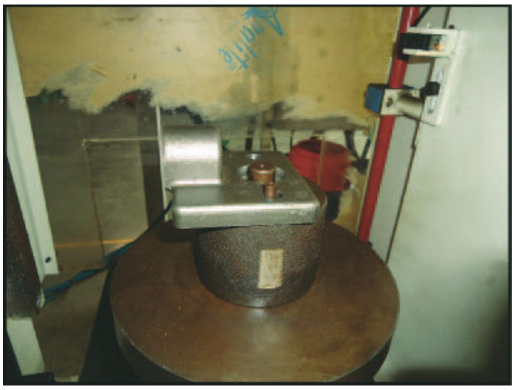
Removal

1. Park the vehicle on level ground and apply parking brake.
2. Pull the hood latch cable and lift the hood.
3. Disconnect the battery terminals
4. Remove the LH platform from the tractor, see operation 5.16 Foot step (page 5A - 14) .
5. Ensure planetary lever in neutral position.
6. Remove the knob(13) and nut(12)
7. Disconnect electrical connection from nuetral safety switch.
8. Remove plug(6),
9. Remove the nuetral safety(15) and ejector pin(14)-(FOR 8x2 ONLY)
10. Slightly adjust the rubber boot(10) and remove 3 precoated sealant screw.
11. Remove the planetary lever assembly from centre housing.
12. Remove the boot(10),spring pin(9)(8) and lever(11).
13. Remove the shaft(2),bush(3),oil seal (4) from housing planetary(5).

Refitment

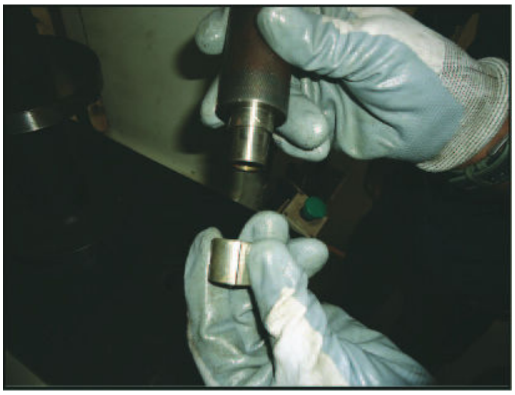
1. Place the planetary housing on the service tool (SER3000007)

NOTE : Refer page no:39 for service tool details

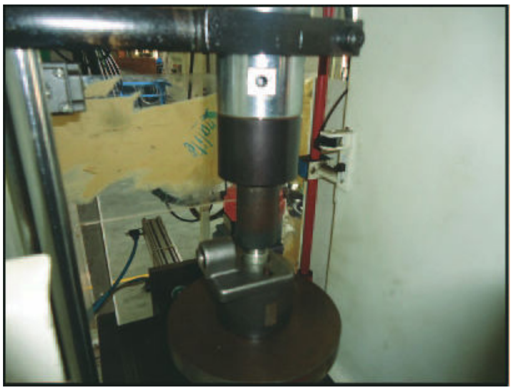


2. Place the bush on the service tool (SER3000007)

NOTE : Refer page no:39 for service tool details

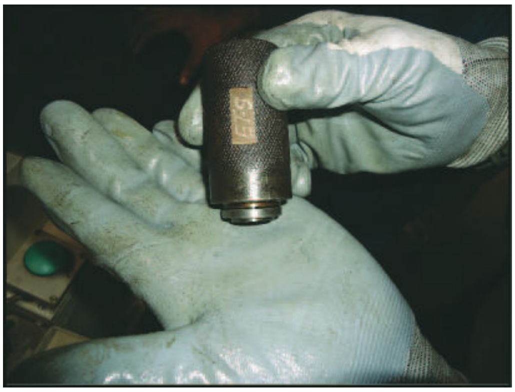


3. Press the bush to the planetary housing using hand press



4. Place the seal in the service tool (SER3000007)

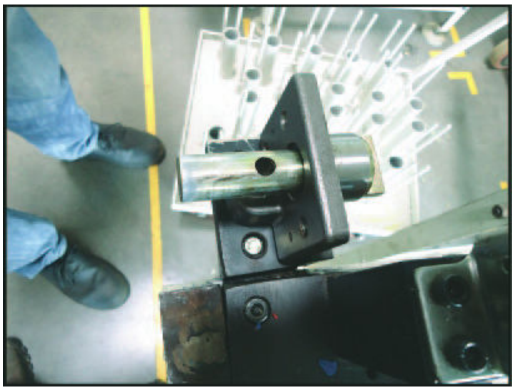
NOTE: The lip of seal to be faced upside
Refer page no:39 for service tool details



Refitment

5. Press the seal in the planetary housing using hand press

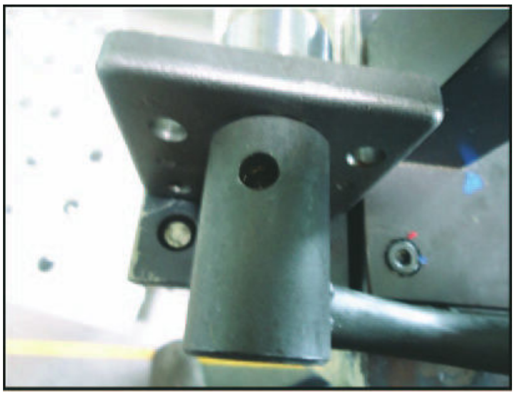
6. Place the planetary lever shaft inside the planetary housing



7. Assemble the planetary shift lever with shaft planetary lever

Refitment

8. Align the hole of planetary shift lever and shaft planetary lever



9. Secure using a spirol pin

10. Assemble the planetary lever sub assembly to the tractor

9A.6 SELECTOR RAILS AND FORKS - CENTER SHIFT

Removal and Refitment

Special Tools:

SER / 054 : Tractor splitting stand

Removal

CAUTION : Beware of the sharp edges around the top of the transmission case.

1. Split the tractor between the centre housing and remove the transmission case.
2. Remove the top cover plate and gasket.
3. Lift out the springs and plungers.
4. Remove the locking wires from the screws.
5. Remove the bolts, balls, pin, stop plate and retainer ball.
6. Remove the locking screw from planetary fork.
7. Remove the planetary fork.
8. Remove the locking screw from shift fork. (Item 5 in Fig. 11).
9. Slide the shift rail rearward out of the transmission and remove the planetary selector.(Item 4 in Fig 11)
10. Remove the screw from 3rd gear fork. (Item 3 in Fig. 11).
11. Remove the screws from shifter fork. (Item 2 in Fig. 11).
12. Slide the rails (1st & R and 2nd & 4th) out of the transmission. (Item 1 in Fig. 11).
13. Rotate the third gear selector rail through 180 deg. (Item 4 in Fig. 12).
14. Remove the selector screw. (Item 1 in Fig. 12).
15. Slide the 3rd gear rail out of the transmission while holding the selector. (Item 3 in Fig. 12).
16. Remove the shifter fork. (Item 2 in Fig. 12).

Refitment

For refitment, follow the reverse procedures given above, and

1. Apply a few drops of oil to the selector rails, plunger and springs before reassembling.

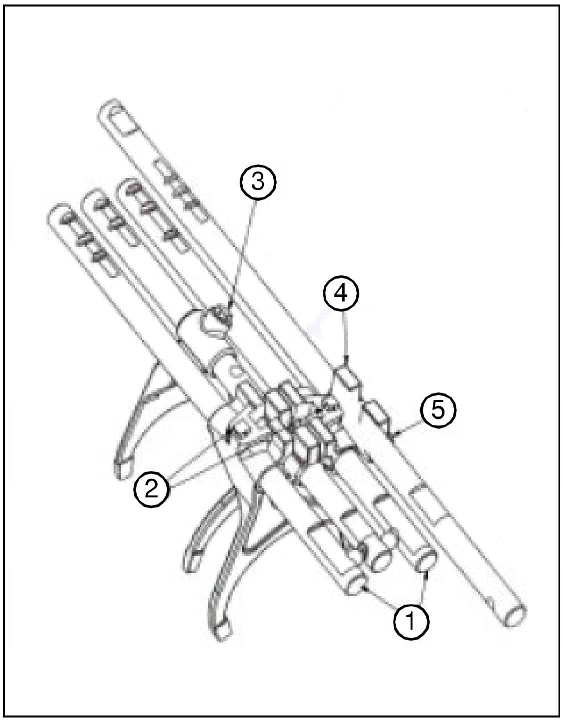


Fig. 11

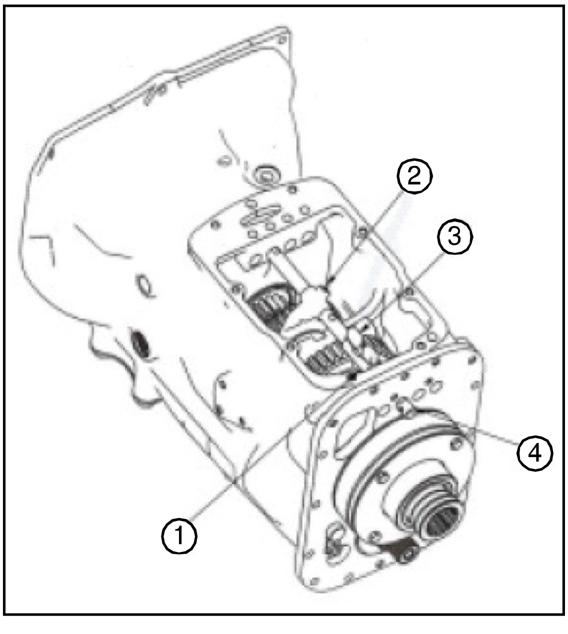


Fig. 12

9A.7 SELECTOR RAILS AND FORKS - SIDE SHIFT

Removal and Refitment

Special Tools:

SER / 054 : Tractor splitting stand

Removal

CAUTION : Beware of the sharp edges around the top of the transmission case.

1. Split the tractor between the centre housing and remove the transmission case.
2. Remove the top cover plate and gasket.
3. Lift out the springs and plungers.
4. Remove the locking wires from the screws.
5. Remove the bolts, balls, pin, stop plate and retainer ball.
6. Remove the locking screw from planetary fork.
7. Remove the planetary fork.
8. Remove the locking screw from shift fork. (Item 5 in Fig. 13).
9. Slide the shift rail rearward out of the transmission and remove the planetary selector.(Item 4 in Fig 13)
10. Remove the screw from 3rd gear fork. (Item 3 in Fig. 13).
11. Remove the screws from shifter fork. (Item 2 in Fig. 13).
12. Slide the rails (1st & R and 2nd & 4th) out of the transmission. (Item 1 in Fig. 13).
13. Rotate the third gear selector rail through 180 deg. (Item 4 in Fig. 14).
14. Remove the selector screw. (Item 1 in Fig. 14).
15. Slide the 3rd gear rail out of the transmission while holding the selector. (Item 3 in Fig. 14).
16. Remove the shifter fork. (Item 2 in Fig. 14).

Refitment

For refitment, follow the reverse procedures given above, and

1. Apply a few drops of oil to the selector rails, plunger and springs before reassembling.

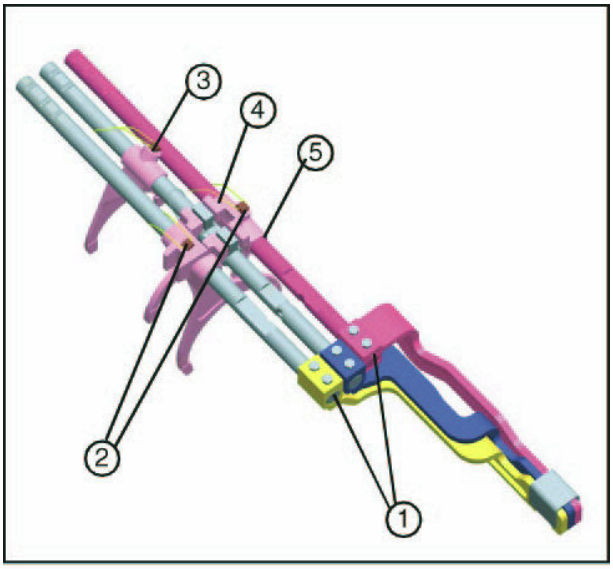


Fig. 13

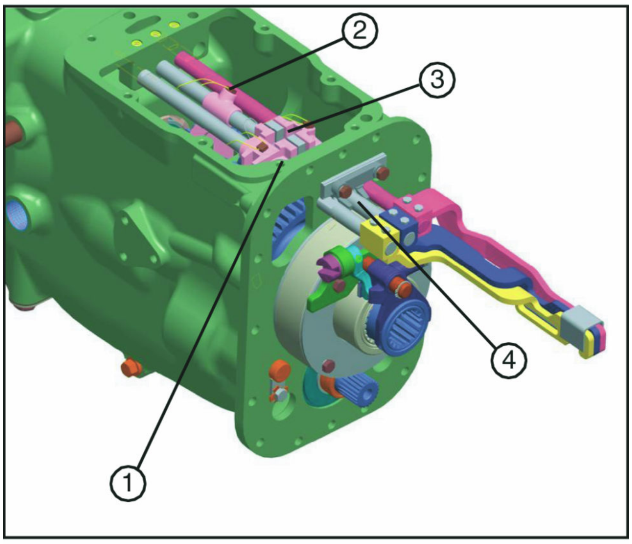


Fig. 14

2. Tighten the ball lock retainer plate bolts to a torque of 32 lbf. ft. (43 Nm).
3. Tighten the shifter fork and selector screws to a torque of 32 lbf.ft (43 Nm.)
4. Use only new wire lock for locking selectors and shifter fork screws.

9A.8 EPICYCLIC UNIT - CENTER SHIFT

Removal and Refitment

Special Tools:

SER / 054 : Tractor splitting stand.

Removal

1. Split the tractor between centre housing and transmission.
2. Remove the planetary fork and coupler (Item 2 in Fig 15).
3. Remove the 4 mounting bolts of ring gear. (Item 1 in Fig 15).
4. Remove the rear cover plate. (Item 3 in Fig 15).
5. Remove epicyclic carrier with rear and front thrust washers. (Item 4 in Fig. 16).
6. Gently tap out the ring gear. (Item 5 in Fig. 16).
7. Remove the front cover plate and shim. (Item 6 in Fig. 16).
8. If necessary, remove the pin dowels from the ring gear. (Item 7 in Fig. 16).

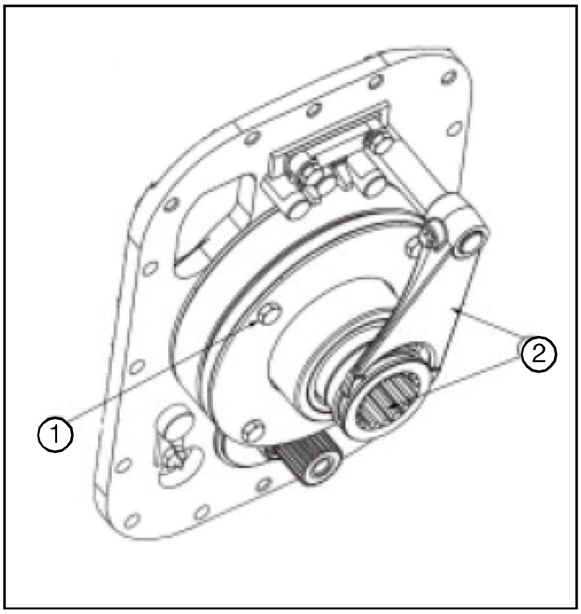


Fig. 15

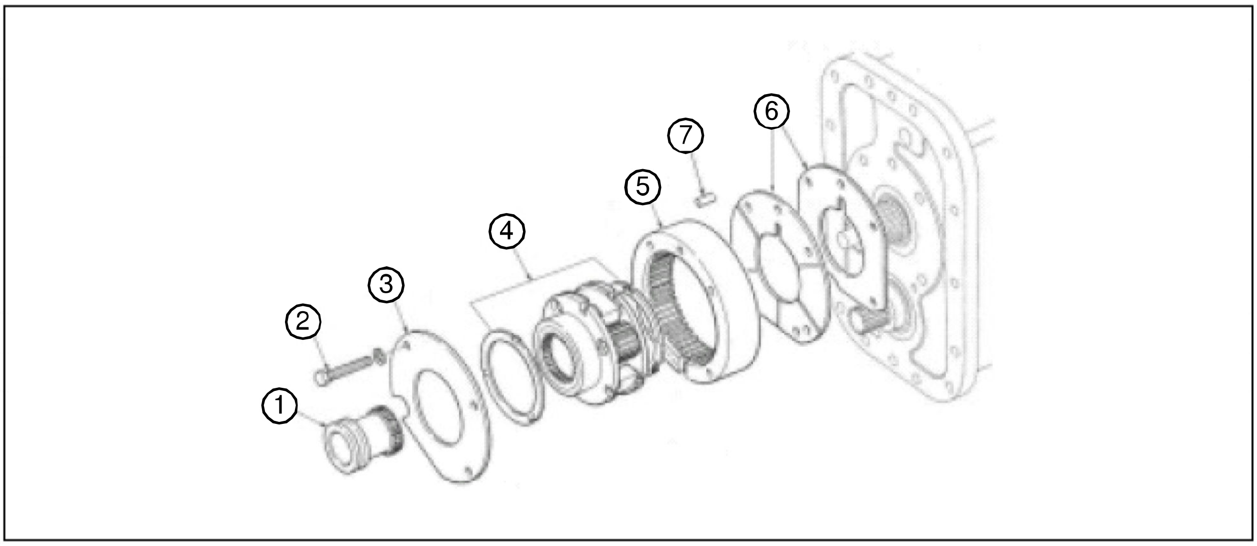


Fig. 16

9A.9 EPICYCLIC UNIT - SIDE SHIFT

Removal and Refitment

Special Tools:

SER / 054 : Tractor splitting stand.

Removal

1. Split the tractor between centre housing and transmission.
2. Remove the 4 mounting bolts of ring gear. (Item 1 in Fig 17).
3. Remove the circlip (Item 23 in Fig. 18).
4. Remove the plunger (Item 21 in Fig. 18), Fork-planetary (Item 22 in Fig. 18), selector shaft planetary (Item 24 in Fig. 18) and Bush HI/LOW (Item 25 in Fig. 18).
5. Remove Selector-planetary (Item 27 in Fig. 18), Slotted pins (Items 28, 29 in Fig. 18).
6. Remove the Assembly bracket planetary (Item 26 in Fig. 18).
7. Remove the rear cover plate. (Item 14 in Fig 18).
8. Remove epicyclic carrier with rear and front thrust washers.

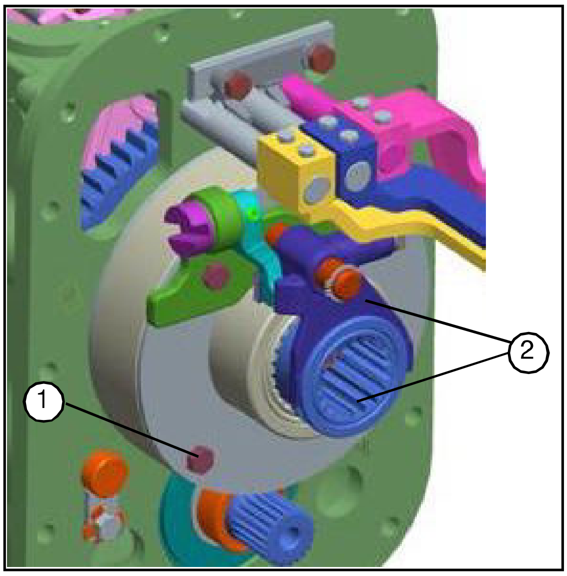


Fig. 17

9. Gently tap out the ring gear. (Item 5 in Fig. 18).
10. Remove the front cover plate and shim. (Item 1,3 in Fig. 18).
11. If necessary, remove the pin dowels from the ring gear. (Item 7 in Fig. 18).

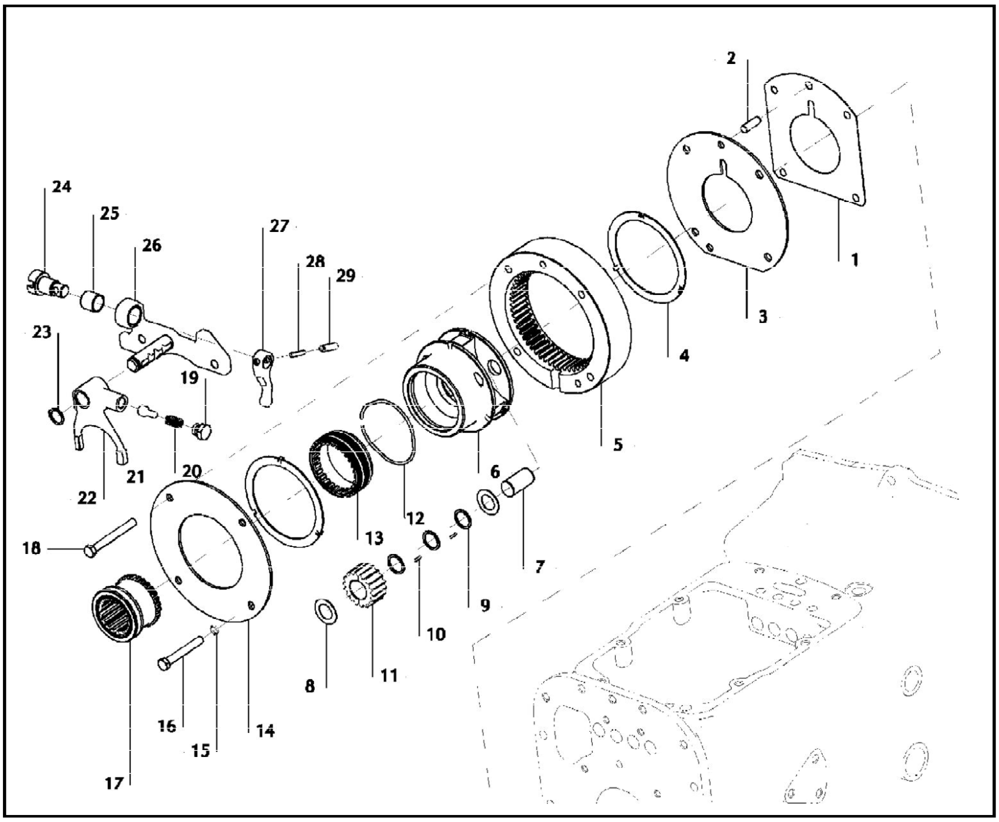


Fig. 18

Examination

Clean and carefully examine all the components, and replace any items that show signs of damage or wear.

Note: *The epicyclic carrier assembly parts cannot be serviced separately, and must be replaced as a complete assembly if found defective.*

Refitment

1. Ensure that the locating dowels are correctly driven in the ring gear.
2. Locate the front plate cover over the ring gear ensuring that the oil grooves face towards the ring gear.
3. Locate the shims over the front plate cover.
4. Position the ring gear with front plate cover and shim on the transmission case ensuring proper seating.
5. Position the two thrust washers on the carrier assembly making sure that the tabs are located in the cutout on carrier assembly. To facilitate fitment of the front and rear thrust washers on the carrier assembly, smear with petroleum jelly (not grease).
6. Insert the carrier assembly with thrust washer into the ring gear and main shaft.
7. Locate the rear cover plate over the carrier assembly making sure oil groove is facing carrier assembly.
8. Do not fit a lock washer to the lower left hand retaining bolt.
9. Refit the mounting bolts and tighten the bolts to a torque of 35 lbf.ft. (47 Nm).

9A.10 CLUTCH RELEASE MECHANISM

Removal and Refitment

Special Tools:

SER / 054 : Tractor splitting stand.

SER / 038 : Hand press tool

Removal and Dis-assembly

1. Split the tractor between the engine and the transmission.
2. Remove the clutch release bearing return spring. (Item 1 in Fig. 19).
3. Slide out the clutch carrier with release bearing from the retainer main drive housing. (Item 2 in Fig. 19).

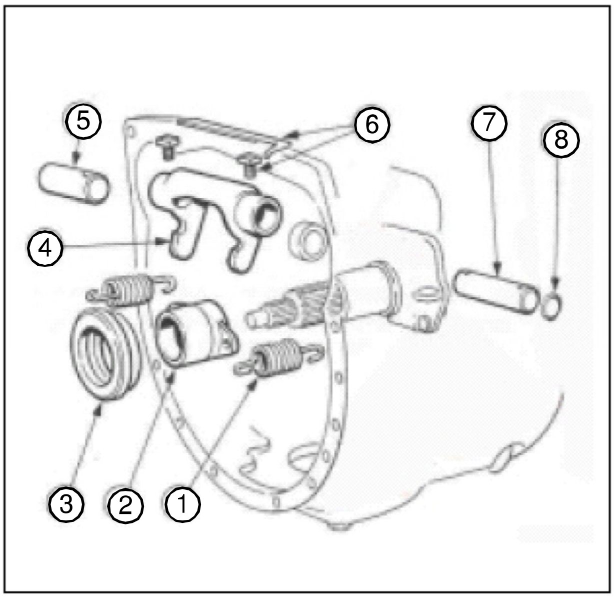


Fig. 19

4. Remove the locking wire and the two locking screws from the clutch release fork. (Item 6 in Fig. 19).
5. Slide out the left - hand clutch pedal pivot shaft with the release arm from the transmission housing.(Item 7 in Fig 19).
6. Remove the right - hand clutch pedal shaft plug.
7. Slide out the right - hand clutch pedal pivot shaft from the transmission housing. (Item 5 in Fig 19).
8. Remove the clutch release fork. (Item 4 in Fig. 19).
9. Remove the bearing from the carrier. (Item 3 in Fig. 19) by using SER / 038 Hand press tool.

Examination

Clean and carefully examine all the components, and replace any item that show signs of damage/wear.

Re-assembly and Refitment

For reassembling and refitment, follow the reverse procedures given above, and

1. Install the clutch pedal shaft with a new ‘O’ ring. (Item 8 in Fig. 19).
2. Install clutch pivot shaft plug .
3. Use new wire lock for locking screws.
4. Lightly smear grease on both input shaft splines and the release bearing carrier bore.
5. Check the free sliding of the carrier assembly over the retainer main drive housing.

9A.11 MAIN DRIVE HOUSING AND PTO PINION SHAFT

Removal and Refitment

Special Tools:

SER / 054 : Tractor splitting stand.
SER / 038 : Hand Press Tool
SER / 076 : Input shaft oil seal replacer.
SER / 075 : Housing Main drive needle bearing remover and replacer.
SER / 036 : PTO Pinion oil seal replacer.
SER / 099 : Oil seal replacer.
SER / 056 : Adaptor for multipurpose bearing remover / replacer.

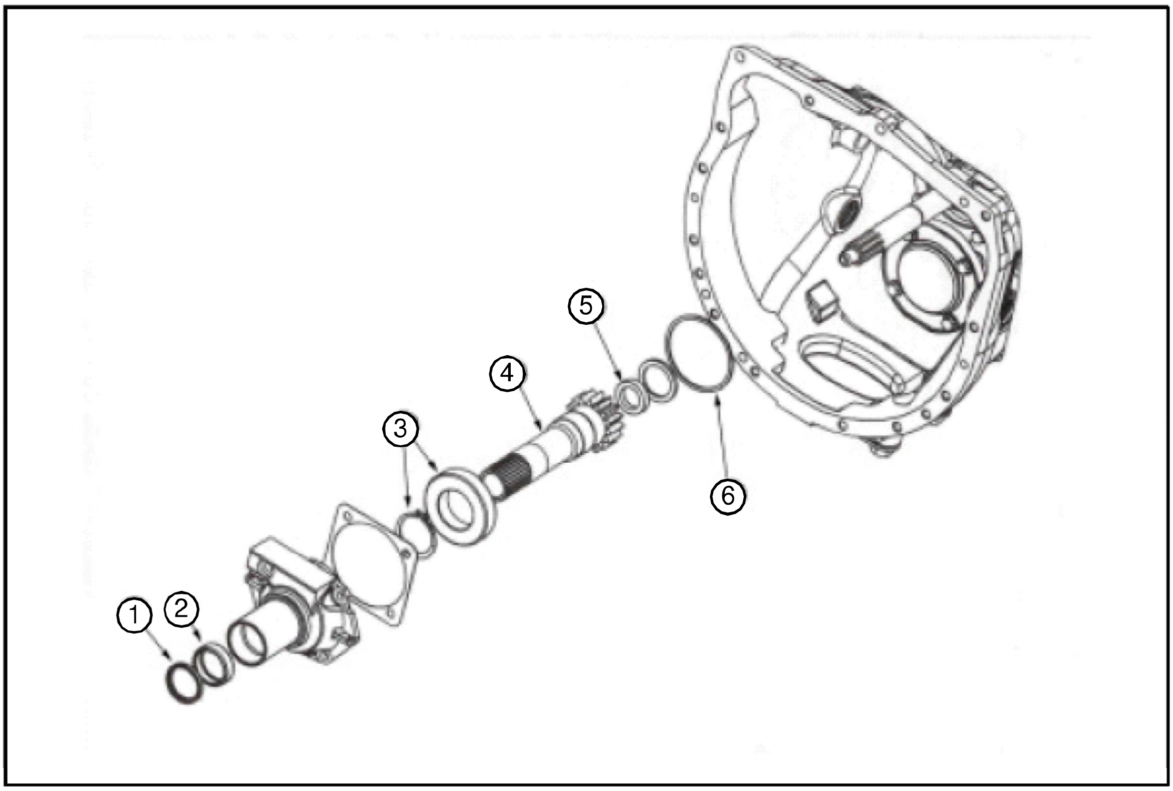


Fig. 20

Removal and Disassembly

1. Remove the clutch release mechanism.
2. Loosen and remove the main drive retainer bolts
3. Remove the main drive retainer housing with PTO pinion shaft and gasket.
4. Remove the PTO pinion shaft retaining ring. (Item 6 in Fig. 20).
5. Push the PTO pinion shaft complete with bearing out of the housing.
6. If necessary remove the circlip and press the bearing off the Shaft. (Item 3 in Fig. 20) by using SER / 038 hand press tool.
7. Remove the PTO pinion shaft oil seal. (Item 5 in Fig. 20).
8. Remove the oil seal from main drive housing (Item 1 in Fig. 20).
9. Remove the needle roller bearing by using SER / 075 (Item 2 in Fig. 20).

Reassembly and Refitment

1. Install the needle roller bearing into the housing by using SER / 075 (Item 2 in Fig. 20).
2. Fit a new oil seal into the housing by using SER / 036 and seal lip facing away from the tool. (Item 1 in Fig. 20).
3. Fit a new oil seal in the PTO pinion shaft with lip of the seal facing the tool by using SER / 076 (Item 5 in Fig. 20).
4. Refit the PTO pinion shaft bearing onto the PTO pinion shaft and refit the circlip, and check that it is properly seated. (Item 3 in Fig. 20).
5. Refit the PTO pinion shaft into the main drive housing.
6. Refit the circlip (Item 6 in Fig. 20) and check that it is properly seated.
7. Smear petroleum jelly to lubricate oil seals lips.
8. Insert the main drive retainer housing with new gasket and PTO pinion shaft into the Input shaft.
9. Replace the housing bolts (pre coated) and tighten the bolts to a torque of 45 lbf. ft. (61 Nm).

9A.12 PTO DRIVE SHAFT BEARING HOUSING

Removal and Refitment

Special Tools:

SER / 054 : Tractor splitting stand.

SER / 038 : Hand Press Tool

Removal

1. Split the tractor between the engine and the transmission.
2. Remove the brake cross shaft.
3. Remove the bolts from the front PTO bearing cover. (Item 1 in Fig 21).
4. Remove front PTO bearing cover with gasket. (Item 3 & 5 in Fig 23).
5. Remove the external ring retainer and washer. (Item 2 in Fig. 23) .
6. Screw two 3/8 UNC X 75 mm (3”) bolts into the bearing housing tapped holes and tighten them evenly to pull out the housing from the transmission case and PTO shaft. (Fig. 22).
7. Remove the ring retainer. (Item 6 in Fig. 23).
8. Press out the bearing. (Item 7 in Fig. 23) by using SER / 038 hand press tool. (Used in conjunction with SER / 056).
9. Remove and discard the gasket. (Item 8 in Fig. 23).

Note: *PTO shaft can only be removed from the rear side of the transmission case. The PTO constant mesh gears can then be lifted out through the top opening of the housing.*

Refitment

1. Refit the bearing into the housing.
2. Refit the ring retainer. Renew if necessary and ensure proper seating in groove.
3. Assemble the constant mesh PTO gears and ensure proper location on the PTO drive shaft.
4. Apply a light coat of recommended sealant over the gasket (Item 8 in Fig. 23)
5. Refit the front PTO housing with bearing onto the PTO drive shaft.
6. Fit a new ring retainer and washer.

For reassembling and fitment follow the reverse procedures of removal.

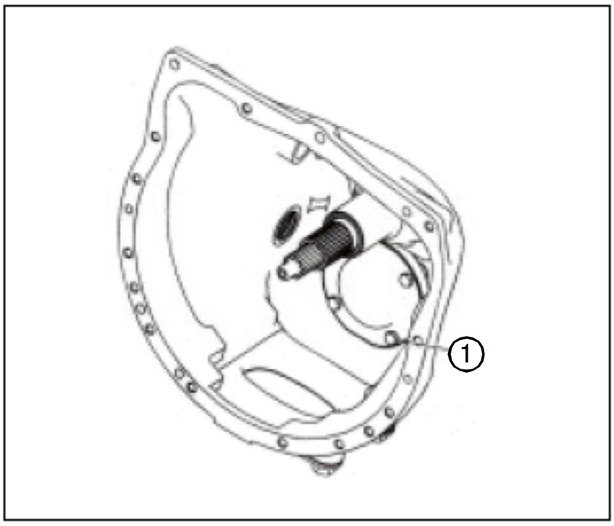


Fig. 21

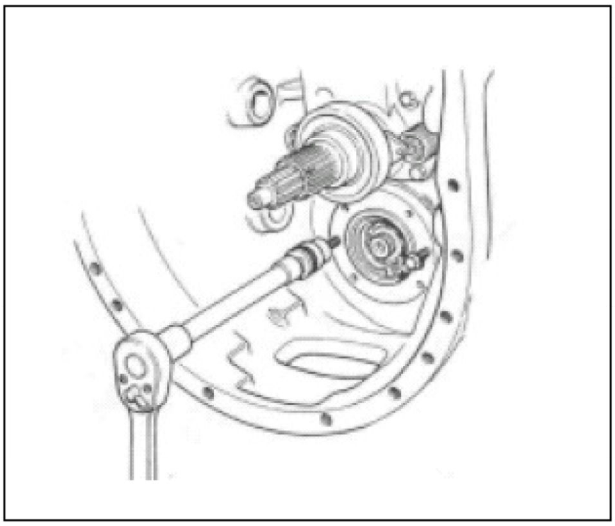


Fig. 22

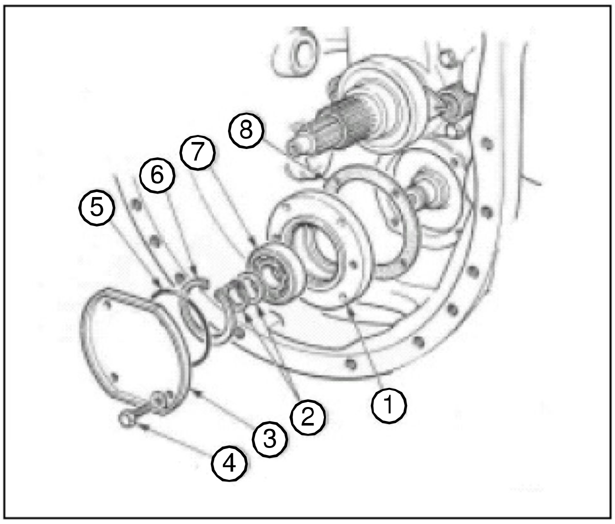


Fig. 23

7. Apply a light coat of recommended sealant to the gasket (Item 5 in Fig. 22) before fitting the front PTO cover with new pre coated bolts.
8. Tighten the bolts to a torque of 45 lbf. ft. (61 Nm).

9A.13 MAIN SHAFT, COUNTER SHAFT AND GEARS

Removal and Dis-assembly

Special Tools:

SER / 054 : Tractor splitting stand.

SER / 036 : Hand Press Tool

SER / 087 : Centralizer

1. Remove the transmission case from the tractor using tractor splitting stand.
2. Remove the selector rails, forks and selectors.
3. Remove the epicyclic unit.
4. Remove the clutch release carrier and release fork.
5. Remove the main drive housing retainer with PTO pinion shaft.
6. Remove the brake cross shaft.
7. Remove the cover and PTO bearing housing.
8. Remove the PTO drive shaft and PTO constant mesh gears.

Input Shaft

1. Remove the input shaft with thrust washers (Item 1 in Fig. 24).
2. Remove the spacer and bearing of the input shaft from the main shaft (Item 2 in Fig. 24).

Main Shaft

1. Remove the 3rd Gear from main shaft. (Item 10 in Fig. 25).
2. Remove the front snap ring. (Item 9 in Fig. 25).
3. Drive the main shaft rearwards out of the front Bearing. (Item 8 in Fig. 25).
4. Remove the rear Snap ring. (Item 7 in Fig. 25).
5. Withdraw the main shaft rearwards lifting out the low speed,intermediate & high gears. (Item 5 and 6 in Fig. 25).
6. Slide out the main shaft with bearing from rear side of the transmission Case. (Item 1 in Fig. 25).
7. Remove the front and rear snap rings. (Item 2 and 4 in Fig. 25).
8. Remove the ball bearing. (Item 3 in Fig. 25) by using SER / 038 hand press tool.

Counter Shaft

1. Remove the snap ring from the front of the counter shaft. (Item 10 in Fig. 26).
2. Remove the snap ring from the rear of the counter shaft (Item 1 in fig 26)

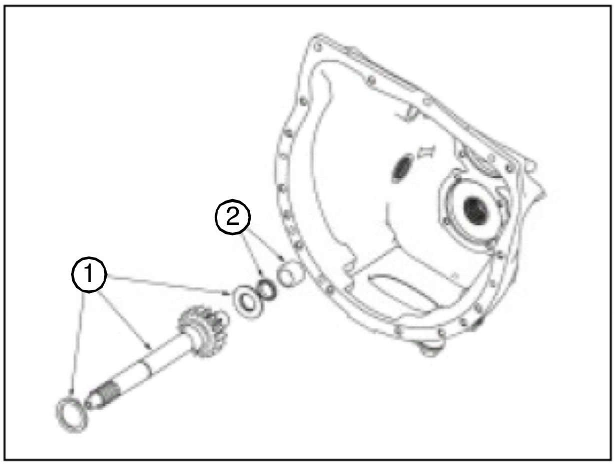


Fig. 24

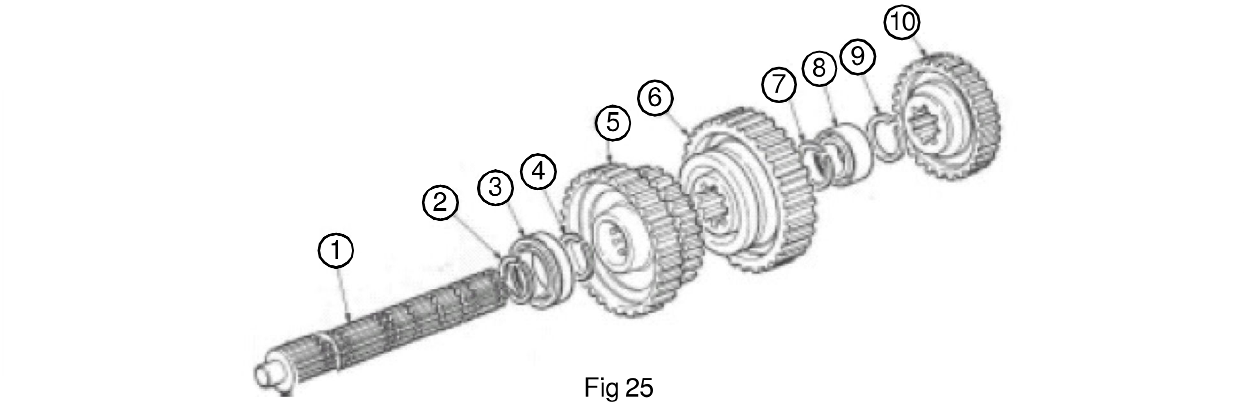


Fig 25

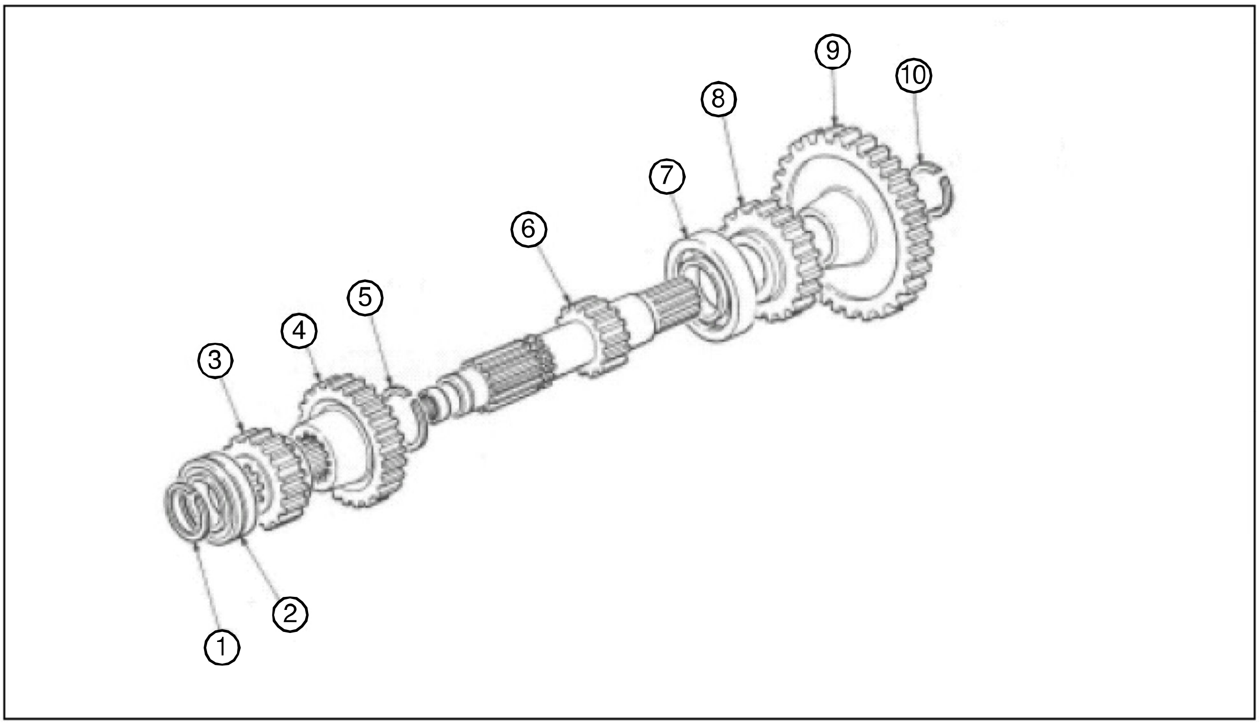


Fig. 26

3. Tap the shaft rearwards and remove the constant mesh gear (Item 9 in Fig. 26) and remove the pinion counter shaft 3rd gear. (Item 8 in Fig. 26).
4. Withdraw the counter shaft forward and remove the pinion intermediate gear and pinion high gear. (Item 3 and 4 in Fig. 26).
5. Slide out the counter shaft from front side of the transmission case. (Item 6 in Fig. 26).
6. Remove the front counter shaft bearing. (Item 7 in Fig. 26) by using SER / 038 Hand press tool.
7. Remove the counter shaft intermediate snap ring if necessary. (Item 5 in Fig. 26).
8. Remove the rear counter shaft bearing from transmission case (Item 2 in Fig. 26).

Reverse Gear Cluster

Note : (see Fig. 27)

1. Release the locking tab-washer. (Item 1 in Fig. 27).
2. Remove the bolt and stop plate. (Item 2 in Fig. 27).
3. Slide the dummy shaft rearwards from the front of the reverse gear shaft. This will push out the shaft reverse cluster and prevent the needle rollers from dropping into the transmission case.
4. Remove the reverse gear cluster (Item 3 in Fig 27) complete with needle rollers, spacer, washers, thrust washers and dummy shaft.
5. Remove the dummy shaft from the reverse gear cluster and release the needle rollers, spacer, washers and thrust washers into a clean tray.

Examination

Clean and carefully examine all the components, especially those subject to movement, and replace any items that show signs of damage or wear.

Note : *Use SER / 087 for reverse gear cluster needle bearing fitment.*

Re-assembly

Note: *All snap rings must be renewed, ensuring that snap rings are correctly located in their groove.*

Reverse Gear Cluster

1. Refit the spacer in the reverse gear cluster. (Item 4 in Fig. 27).
2. Lightly pack the inside of the reverse gear cluster with petroleum jelly.
3. Refit the first set of 28 rollers. (Item 5 in Fig. 27).
4. Refit the washer. (Item 6 in Fig. 27).

5. Refit the second set of 28 rollers. (Item 5 in Fig. 27).
6. Refit the washer. (Item 6 in Fig. 27).
7. Refit the thrust washers on both side of the reverse gear cluster. (Item 7 in Fig. 27).
8. Refit the reverse cluster assembly with thrust washers in transmission case and slide the reverse gear cluster shaft into the transmission case. Ensure that the thrust washers and needle bearings are not dislodged.
9. Position the washer-spacer into the rear of the reverse gear cluster. (Item 8 in Fig. 27).
10. Locate the stop plate and fit a new lock tab-washer to lock the bolt and tighten the bolt to torque.

Counter Shaft

For reassembling, follow reverse procedures of counter shaft removal .

Main Shaft

For reassembling, follow reverse procedures of Main Shaft removal .

Input Shaft

For reassembling, follow reverse procedures of Input shaft removal and ensure that the thrust washer is fitted with the oil groove facing the main shaft.

For reassembling the rest of the transmission, follow the reverse procedure of removal and dis-assembly 1 to 8 of operation No. 9A. 13

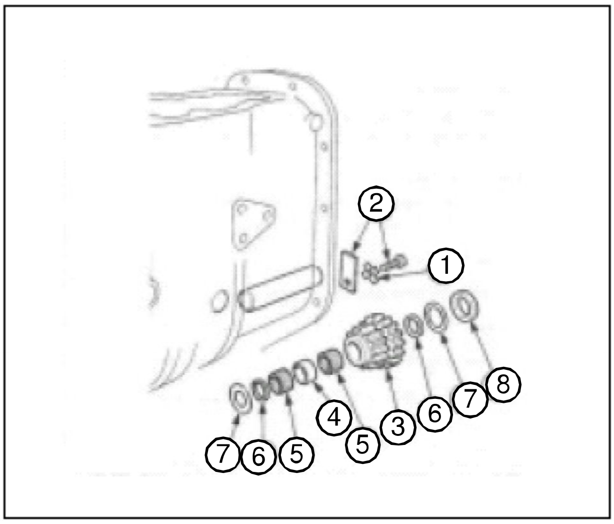
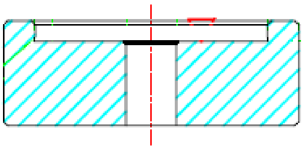
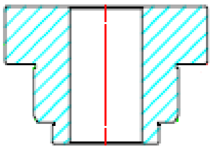
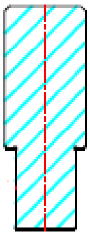
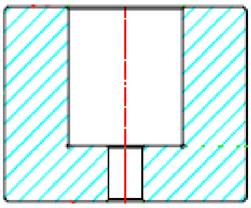
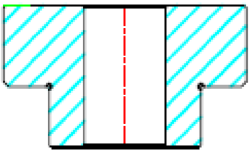
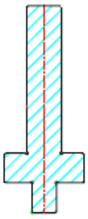
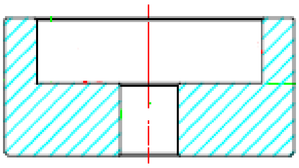
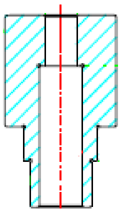
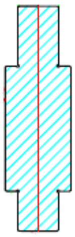
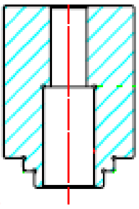
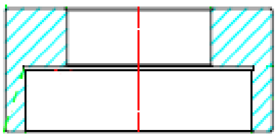
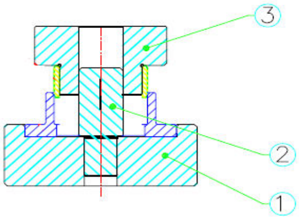
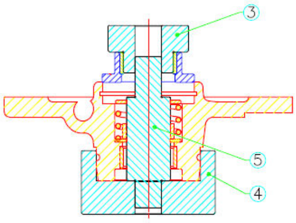
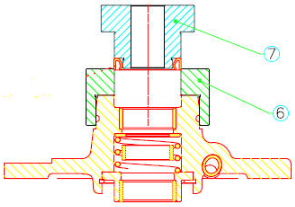
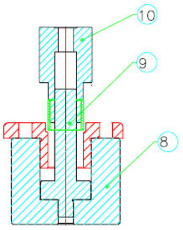
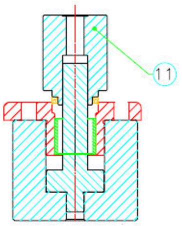


Fig. 27

9A.14 - SIDE SHIFT - SERVICE TOOL DETAILS

SL NO	IMAGE	DESCRIPTION	SL NO	IMAGE	DESCRIPTION
1		Locator	7		Pusher
2		Guide	8		Locator
3		Pusher	9		Guide
4		Locator	10		Pusher
5		Guide	11		Pusher
6		Locator			

9A.14 - SIDE SHIFT - SERVICE TOOL DETAILS

SERVICE TOOL NUMBER	DESCRIPTION	IMAGE	REMARKS
SER3000007	Pressing tool (Bush to collar)		1- Locator 2- Guide 3- Pusher
	Guiding tool (SS housing)		4- Guide 5- Locator
	Pressing tool (Seal into SS housing)		6- Locator 7- Pusher
	Pressing tool (Bush into Planetary hsg.)		8- Locator 9- Guide 10- Pusher
	Pusher		11- Pusher

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SECTION 9

TRANSMISSION

INDEX

Part B

9B - 8 X 8 SYNCHROMESH GEAR BOX - DUAL CLUTCH

TABLE OF CONTENTS

Operation no.	Descripition	Page no.
9B . 1	Specification	9B - 3
9B . 2	General descripition	9B - 3
9B . 3	Gear shift levers - Center shift	9B - 8
9B . 4	Gear shift levers - Side shift	9B - 9
9B . 5	Shuttle control lever	9B - 28
9B . 6	Forward/Reverse (Shuttle) control lever	9B - 29
9B . 7	Selector rails and forks - Center shift	9B - 30
9B . 8	Selector rails and forks - Side shift	9B - 31
9B . 9	Normal duty epicyclic unit - Removal - Center shift	9B - 32
9B . 10	Normal duty epicyclic unit - over haul - Center shift	9B - 33
9B . 11	Epicyclic unit - Side shift	9B - 34
9B . 12	Input shafts and housing - Removal	9B - 35
9B . 13	PTO drive shaft front bearing - removal	9B - 36
9B . 14	Layshaft , mainshaft , PTO shaft and gears - Overhaul	9B - 37
9B . 15	Side shift service tool details	9B - 44

9B.1 SPECIFICATION:

Model - 8 Speed synchromesh shuttle gear box.
No.of gears - Forward - 8
No.of gears - Reverse - 8

Setting required:

Main shaft end float - 0.003 - 0.011 inch (0.080 - 0.30 mm)
Type of adjustment - Variable thickness thrust washer.
Synchromesh ring to coulper clearance - installed - 0.031 inch (0.8 mm).
Synchromesh ring to coupler clearance - removed - 0.019 inch (0.5 mm).
Epicyclic reduction unit - 4:1 - Normal duty only.

Special Tools:

MF.218 B - PTO bearing housing replacer.
MF.255 B - PTO input shaft oil seal replacer.
MF.315 A - Needle roller bearing remover / replacer.
MF.414 A - Synchromesh centralising pin.
MF.415 - Synchromesh hub assembly tool.
MF.421 - Needle roller bearing and seal replacer.
MF.422 A - Needle roller bearing and seal remover.
MS.550 - Drive handle.
MF.177A - Input shaft oil seal protector sleeve.
SER3000007 - Side shift & high/low service tool

Bolt Torques

Steering wheel nut - 35 lbf.ft. (47 Nm).
Gear lever cover to gearbox top - 83 lbf.ft. (112 Nm).
Shifter fork locking screws - 32 lbf.ft. (44 Nm).
Interlock mechanism bolt to gearbox case - 32 lbf.ft. (44 Nm).
Epicyclic unit to gearbox case - 32 lbf.ft. (44 Nm).
Input shaft housing to gearbox case - 43 lbf.ft. (58 Nm).
PTO drive shaft bearing housing to gear box - 43 lbf.ft. (58 Nm).

9B . 2 GENERAL DESCRIPTION:

The 8 Speed Synchromesh Shuttle Gearbox has eight forward and eight reverse gears; the forward reverse (shuttle) selection being controlled by a lever on the instrument panel adjacent to the steering wheel. It provides full engine braking on over-run and enables the tractor to be towed to start the engine.

Drive arrangements

From the constructional viewpoint the gearbox has three sections. The front section consists of the forward and reverse gears with synchromesh coupler.

The centre section comprises constant mesh gear sets giving four basic forward and reverse speeds with synchromesh engagement on all gears while the rear section consists of an epicyclic gear reduction unit offering an alternative low range output drive ratio. The four basic forward and reverse speeds are doubled by the ability of the epicyclic unit to provide the additional output ratio. This feature, doubles the number of speeds available and gives the gearbox a total of eight forward speeds and eight reverse.

The gearbox mainshaft is located above the layshaft which is of hollow construction to accept the power take-off (PTO) drive shaft which runs within it. Drive from the engine enters the gearbox through the input shaft which is spigot mounted at its front end into the mainshaft. The forward and reverse gears are splined to the input shaft and are in constant mesh with corresponding free-running gears on the front of the layshaft. The front or reverse gears drive through an idler gear to give the reverse motion. Drive through either of these free-running gears occurs when the one selected is engaged with the layshaft by the sliding coupler of the synchromesh mechanism.

The PTO drive enters the gearbox through a hollow shaft revolving on the outside of the gearbox input shaft. A spur gear pinion at the rear of the hollow PTO input shaft is permanently engaged with the gear splined to the PTO drive shaft. The mainshaft carries four free-running gears, all of which are in constant mesh with corresponding fixed gears on the layshaft to give the basic 1st, 2nd, 3rd and 4th ratios.

The 2nd, 3rd and 4th ratio, forward and reverse gear sets are of the straight cut spur type. The 1st ratio gear set has helical teeth which have longer contact areas and are consequently capable of transmitting greater loads than straight cut gears of the same size. They are also quieter running.

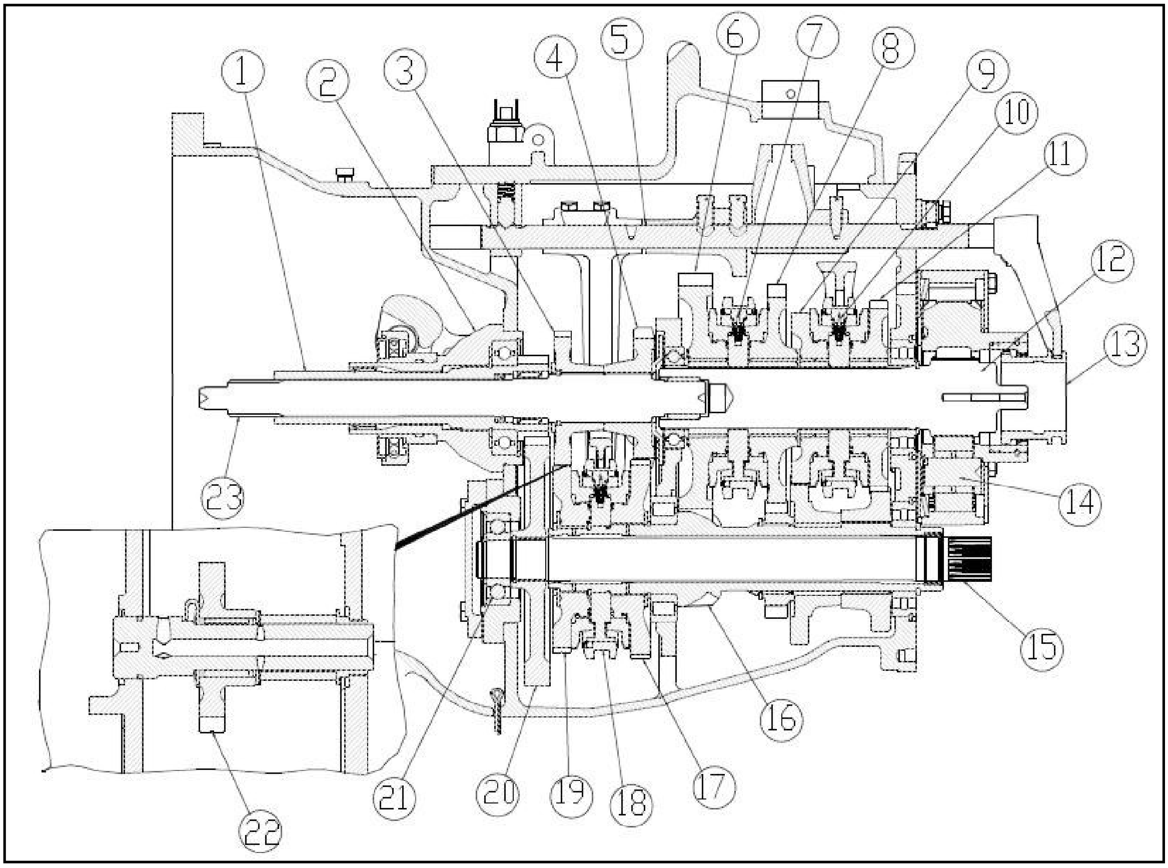

Fig 1

CENTER SHIFT

1. PTO input shaft and gear
2. Input shaft housing
3. Reverse gear constant mesh drive gear
4. Forward gear constant mesh drive gear
5. Selector rails and forks
6. 1st speed driven gear
7. 1st/2nd gear synchronized coupler
8. 2nd speed gear
9. 4th speed driven gear
10. 3rd/4th gear synchronized coupler
11. 3rd speed driven gear
12. Main shaft (or output shaft)
13. Low/High range coupling sleeve
14. Epicyclic reduction unit: low/high range selection
15. PTO output shaft
16. Layshaft (lower)
17. Forward gear constant mesh driven gear
18. Forward/reverse synchronized coupler
19. Reverse gear constant mesh driven gear
20. PTO constant mesh gear
21. PTO front bearing housing
22. Reverse speed idler gears
23. Transmission input shaft

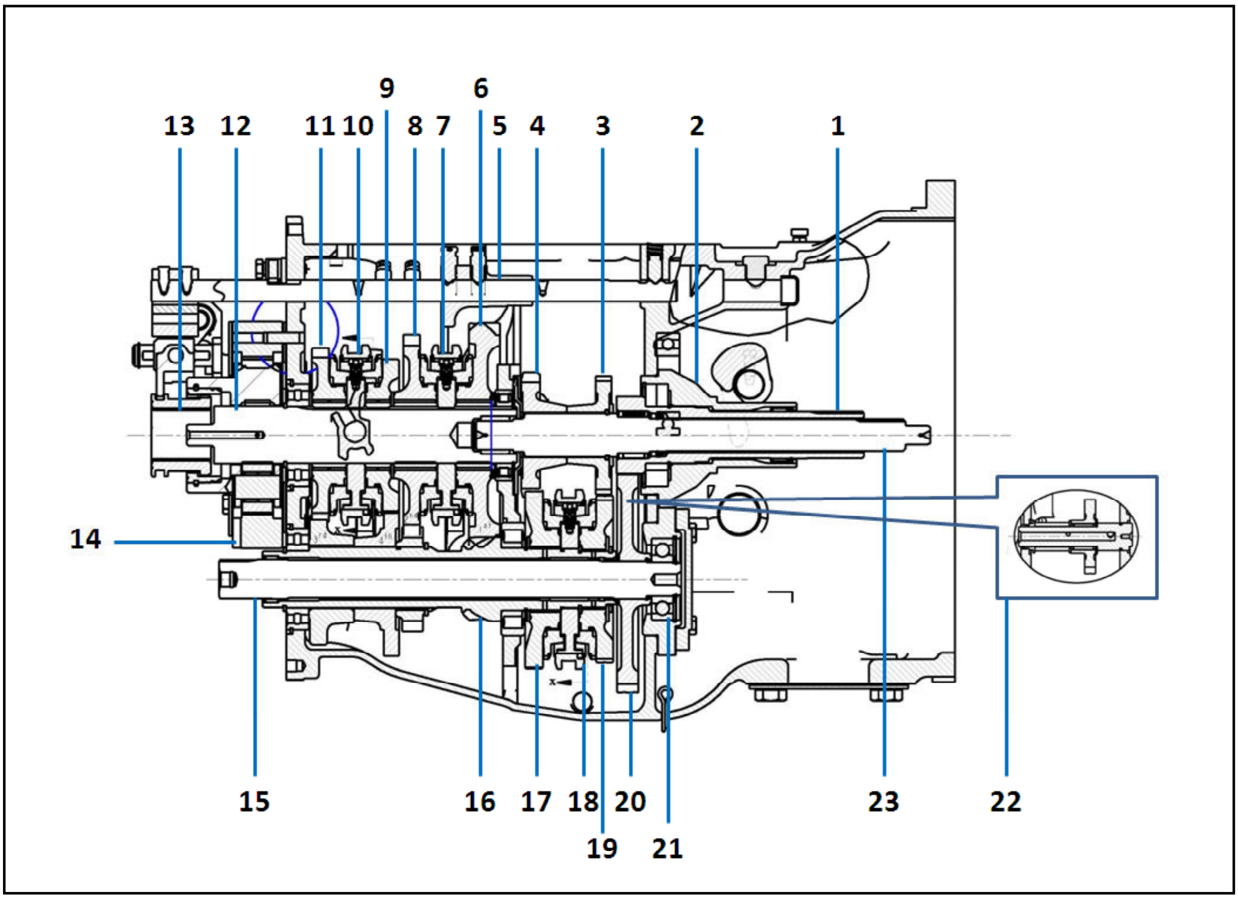

Fig 2

SIDE SHIFT

1.	PTO input shaft and gear
2.	Input shaft housing
3.	Reverse gear constant mesh drive gear
4.	Forward gear constant mesh drive gear
5.	Selector rails and forks
6.	1st speed driven gear
7.	1st/2nd gear synchronized coupler
8.	2nd speed gear
9.	4th speed driven gear
10.	3rd/4th gear synchronized coupler
11.	3rd speed driven gear
12.	Main shaft (or output shaft)
13.	Low/High range coupling sleeve
14.	Epicyclic reduction unit: low/high range selection
15.	PTO output shaft
16.	Layshaft (lower)
17.	Forward gear constant mesh driven gear
18.	Forward/reverse synchronized coupler
19.	Reverse gear constant mesh driven gear
20.	PTO constant mesh gear
21.	PTO front bearing housing
22.	Reverse speed idler gears
23.	Transmission input shaft

Drive through the 1st, 2nd, 3rd and 4th ratio free running gears takes place when the selected gear is engaged with the mainshaft by a sliding coupler. The coupler located between the pairs of gears forms part of the synchromesh engagement mechanism. Ball and roller bearings are used to support the main and layshaft.

Gearbox Driveline

The order of drive through the gearbox, with the gears selected is as follows:

1. From the input shaft through the forward or reverse gear set to the layshaft.
2. From the layshaft to the selected free running gear on the mainshaft.From the free-running gear to the coupler.
3. From the coupler to the mainshaft via the coupler hub which is splined to the mainshaft.
4. From the mainshaft to the tractor's final drive arrangements via the epicyclic gear reduction unit in LOW range drive or directly in HIGH range.

Synchromesh mechanism:

The synchromesh mechanism synchronises (equalises) the speed of the selected free-running gear with the appropriate driven shaft before drive engagement. This is of great benefit to the drive by preventing potential gear damage and allowing fast, easy gear changes to be made on the move without the need to stop the tractor. Engaging gear with the tractor stationary is also easier.

CAUTION: The tractor MUST come to rest before changing direction from forward to reverse or reverse to forward.

Epicyclic gear reduction unit:

Up to this point only passing reference has been made to the epicyclic gear reduction unit at the rear of the gearbox. This is of normal-duty design.

The rear end of the mainshaft is machined to form the sun gear which meshes with three planet gears, also in mesh with a fixed internal ring gear or 'annulus' forming the circumference of the working components. When the mainshaft rotates, the planet gears and carrier revolve round the sun gear at a reduced speed compared with that of the mainshaft.

A sliding coupler with internal and external splines forms the connection between the gearbox and the drive shaft to the final drive. When moved forwards by its output lever, it couples the mainshaft directly to the output shaft to establish high range drive, giving the gearbox an additional set of speed ratios 5th, 6th, 7th, 8th and high reverse.

When shifted fully rearwards the external splines on the coupler engage corresponding splines on the planet carrier to establish low range drive. In these circumstances, drive from the gearbox mainshaft to the output shaft is via the carrier and subject to a speed reduction giving 1st, 2nd, 3rd and 4th speed ratios and low reverse. The coupler may also be placed in a mid or neutral position free of the mainshaft and carrier to totally disconnect the drive from the gearbox - a feature forming the basis of the Massey Ferguson neutral starting arrangements.

GEAR SHIFT LEVER ARRANGEMENT - CENTER SHIFT

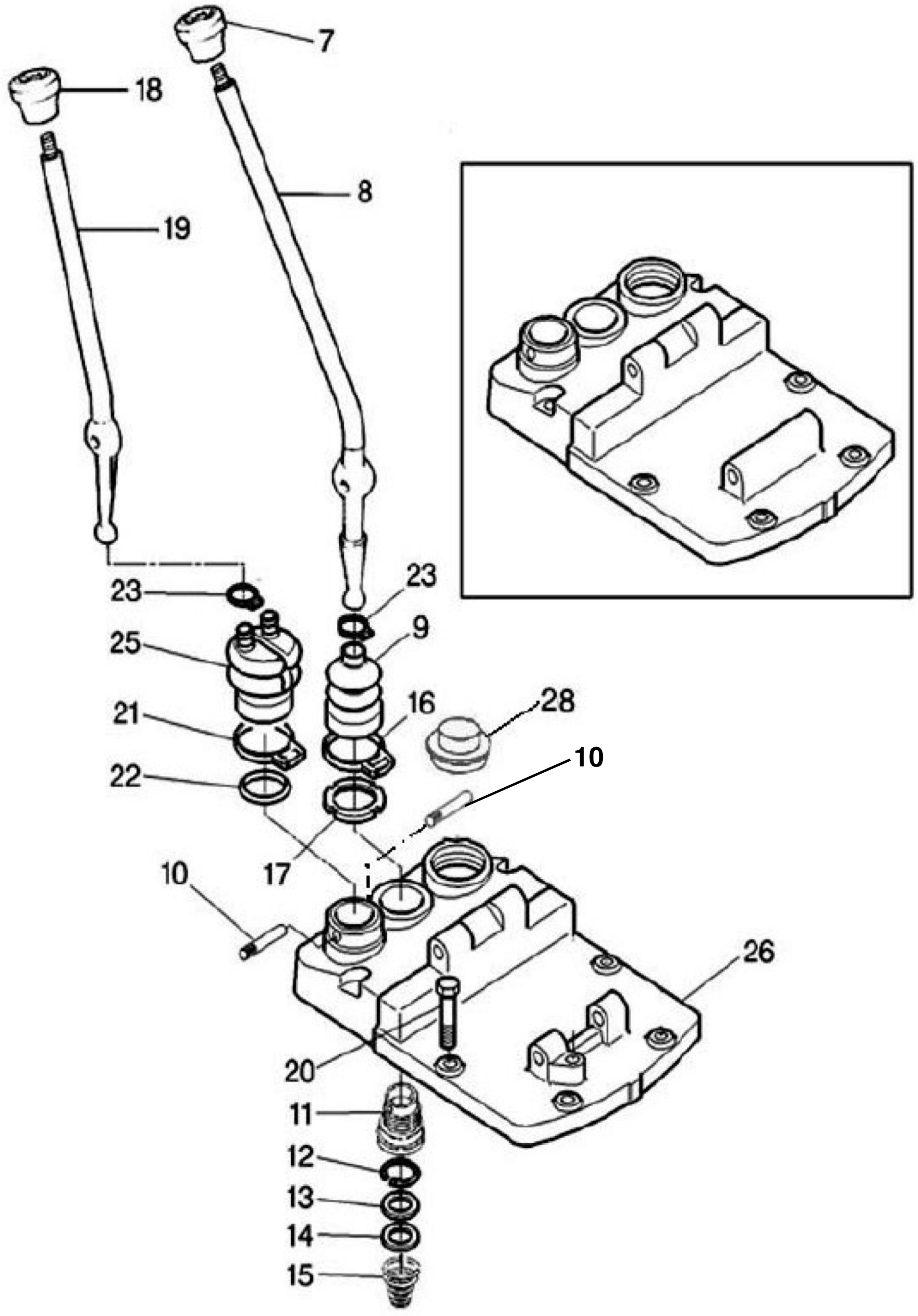
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Fig 3

9B.3 GEAR SHIFT LEVERS - CENTER SHIFT

Removal and refitment

Removal

1. Remove the steering wheel, instrument panel and other parts necessary to gain access to the gearbox top.
2. Remove the split pin and clevis pin and disconnect the linkage from the forward/reverse gear lever.
3. Disconnect the hydraulic hoses to the hydrostatic steering unit.
4. Remove the Hydrostatic steering unit assembly.
5. Move all the gear levers into the neutral position.
6. Remove the bolts securing the top cover assembly to the gearbox(item 20 in fig 2).
7. Remove the assembly from the tractor and place on a work bench.

Main gear lever:

8. Remove the gear lever knob (item 7 in fig 2).
9. Remove the rubber cover(item 9 in fig 2).

WARNING: Spring under compression.

10. Turn the assembly over and unclip the spring retaining clip (item 12 in fig 2).

11 Remove the spring(item 15 in fig 2)

12. Remove the retaining pin(item 10 in fig 2).
13. Remove the main gear lever (item 8 in fig2).
14. Remove the gear lever cup and discard the ‘O’ ring. High/low and shuttle gear lever (item 22 in fig 2)
15. Remove the knob (item 18 in fig 2).
16. Remove the rubber cover (item 25 in fig 2).
17. Remove the retaining pin (item 10 in fig 2).
18. Remove the shuttle gear lever.
19. Remove the high/low gear lever (Item19 in fig 2).

Refitment:

20. Reverse procedures 1 to 19 except:

a. Replace the rubber covers to prevent dirt getting into the transmission.

b. Coat the underside of the cover with MF Instant Gasket (Loctite 515) and torque the cover bolts to 83 lbs.ft. (112 Nm).

c. Tighten the steering wheel nut to a torque of 35 lbs.ft. (47 Nm).

9B.4 GEAR SHIFT LEVERS - SIDE SHIFT

Removal and refitment

Removal

1. Park the vehicle on level ground and apply parking brake.
2. Pull the hood latch cable and lift the hood.
3. Disconnect the battery terminals
4. Remove the platform from the tractor, see operation 5.16 Foot step (page 5A - 14).
5. Check whether side shift in neutral position.
6. Remove the dipstick
7. Remove 4 bolts, 1 allen head screw and 1 nut in side shift cover
8. Remove M5 nut from side shiftcover
9. Disconnect the response lever by removing a cotter and a clevis pin.
10. Remove the side shift assembly from centre housing.
11. Keep the side shift assembly in suitable fixture.

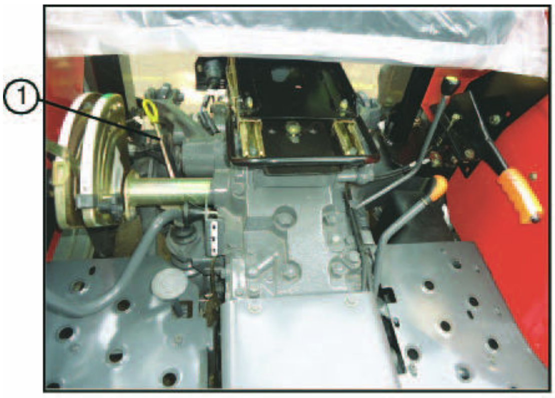

Fig 4

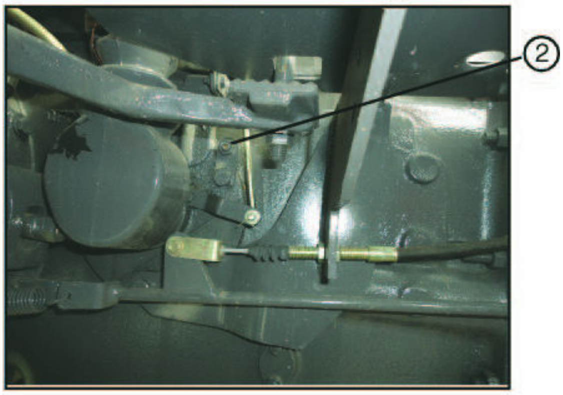

Fig 5

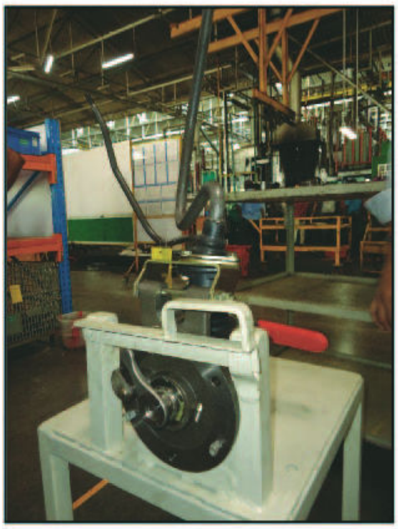

Fig 6

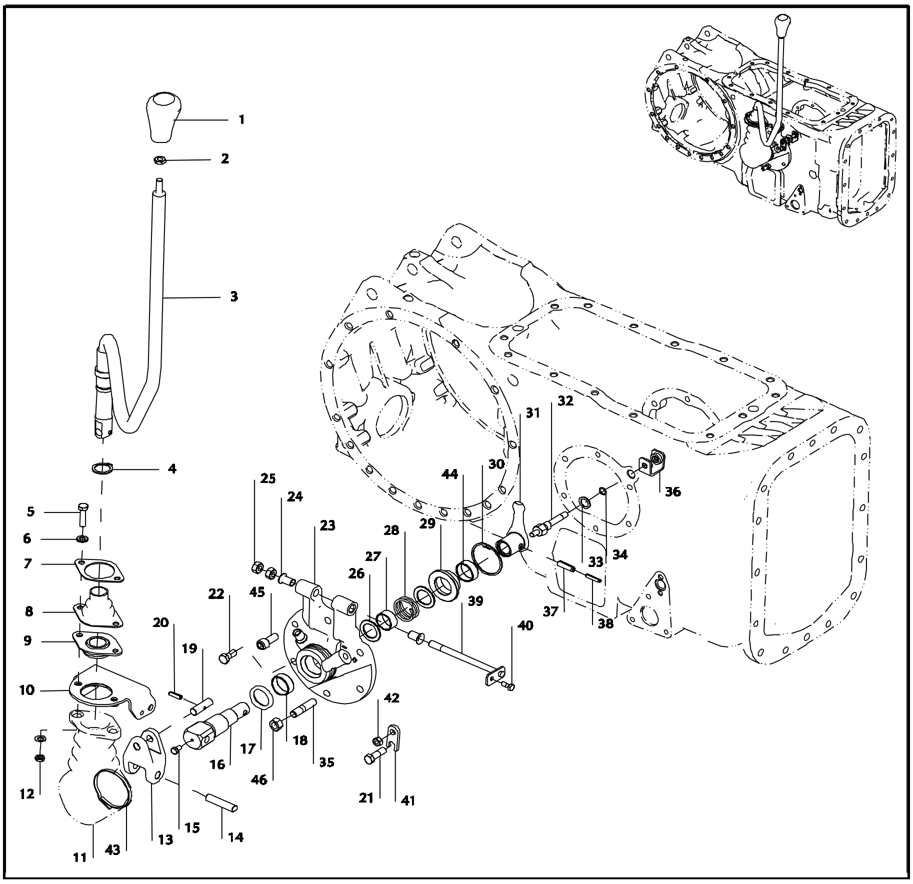
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Fig 7

Removal - side shift Gear lever

1. Remove knob(1) and M5 nut(2).
2. Remove the strap(43) and slightly lift the rubber boot(11) for easy accessability.
3. Remove the spring pin(20) and pin (19).
4. Remove the M5 nut(25),M6 bolt(40) and pin assy(39).
5. Remove circlip(4),bolt(5),washer(6),and nut(12).
6. Remove the plate(7),boot(8),assembly ball(9), pivot plate(10) and rubber boot(11).

Removal - side shift housing

7. Remove the M6 bolt(15) and pin (14).
8. Remove the spring pin(38)(37) and selector pawl(31).
9. Remove the shaft(16).
10. Remove the pin (5) and remove the cam (6) and spring (7) - Refer fig: 9.
11. Remove the pin (13) and remove the lever (15), shaft (12) and washer (11) - Refer fig: 9.
12. Remove the circlip(30), bush(44) , collar(29), washer(26), spring(28) and spacer(27) .
13. Remove oil seal(17) and bush(18).

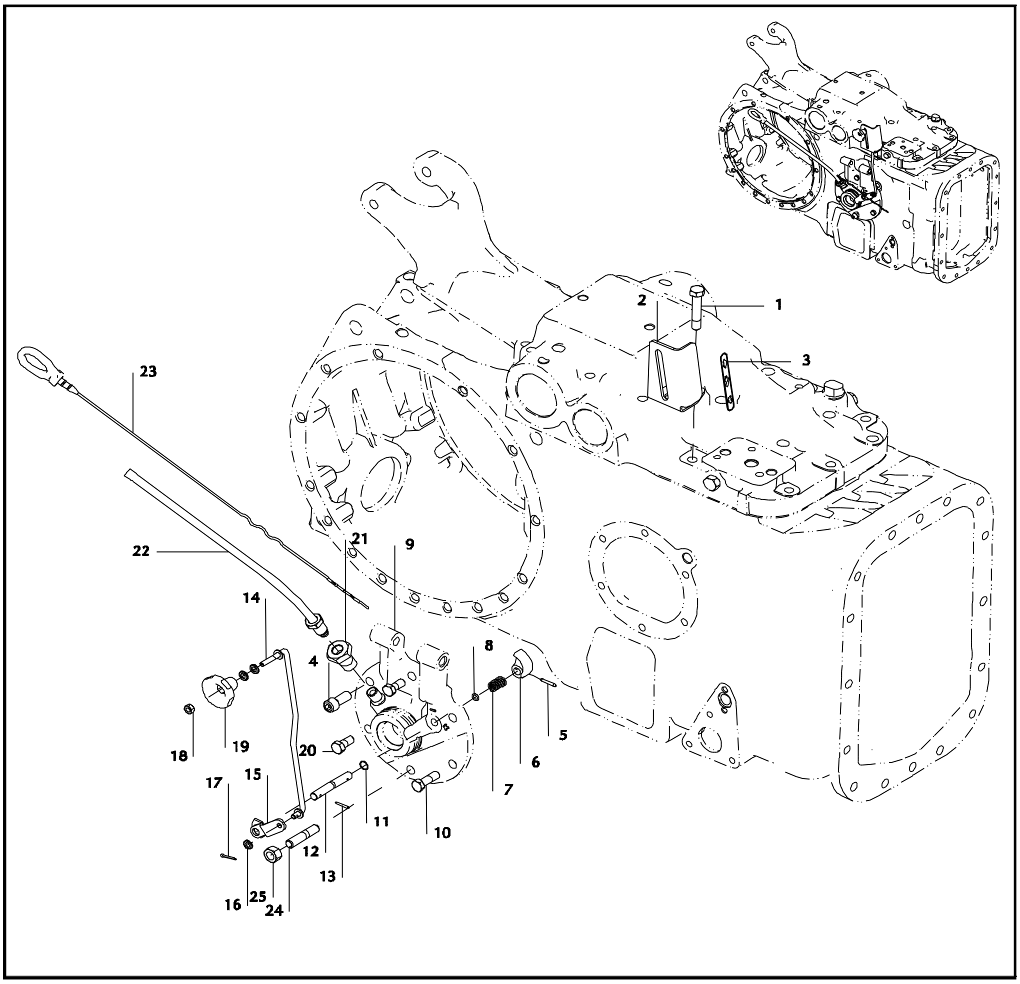
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Fig 8

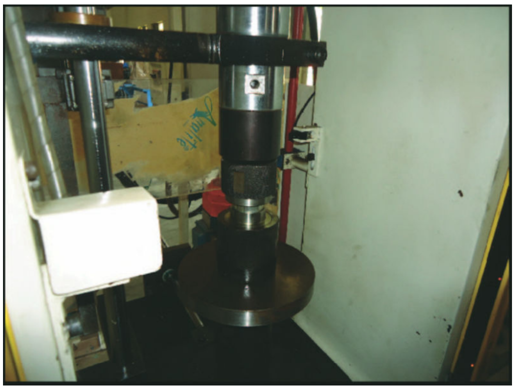
Refitment

1. Place the collar on the table

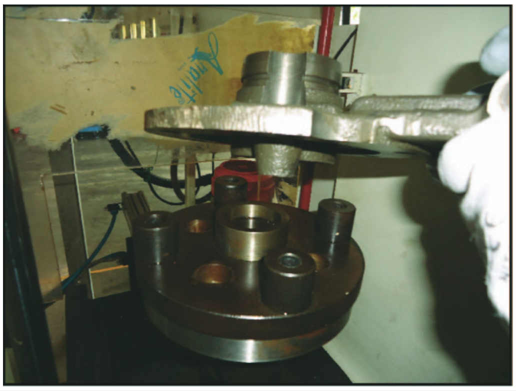
2. Place the bush in the service tool (SER3000007) as shown

NOTE : Refer page no:45 for service tool details

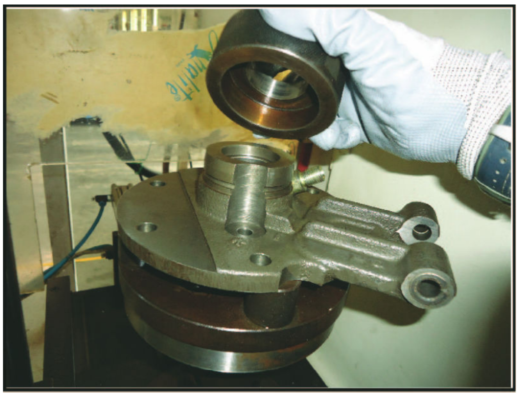
3. Press the bush inside the collar using a hand press



4. Place the side cover housing on a suitable work bench as shown

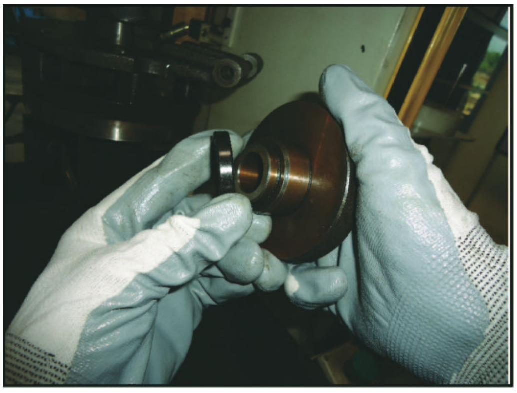


Refitment



5. Place the service tool (SER3000007) on the side cover housing as shown

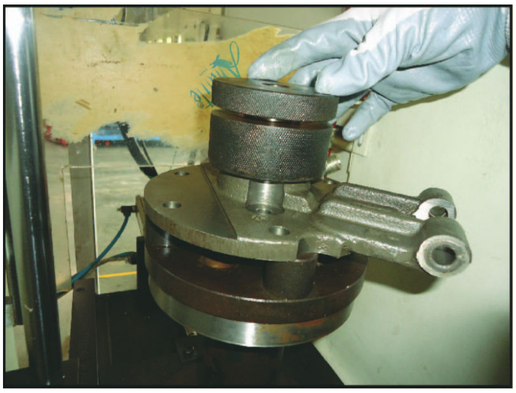
NOTE : Refer page no:45 for service tool details



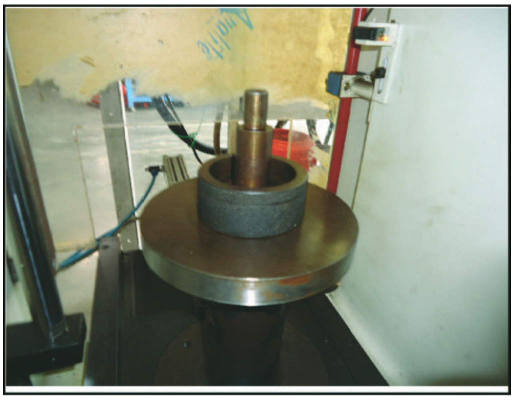
6. Fix the seal on the service tool (SER3000007)

NOTE: The lip of the seal to be faced up

NOTE : Refer page no:45 for service tool details



7. Place the seal on the side cover housing and press using a hand press

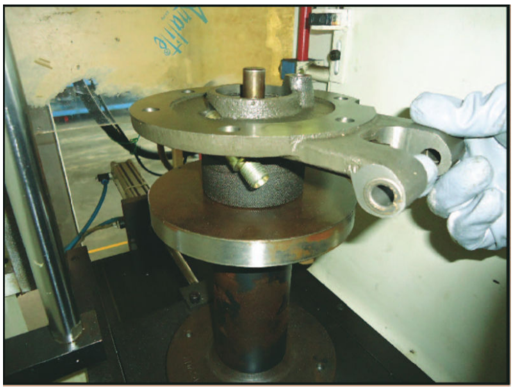


8. Place the service tool (SER3000007) on the work bench as shown

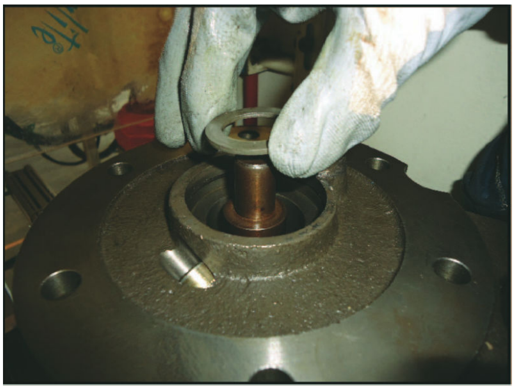
NOTE : Refer page no:45 for service tool details

Refitment

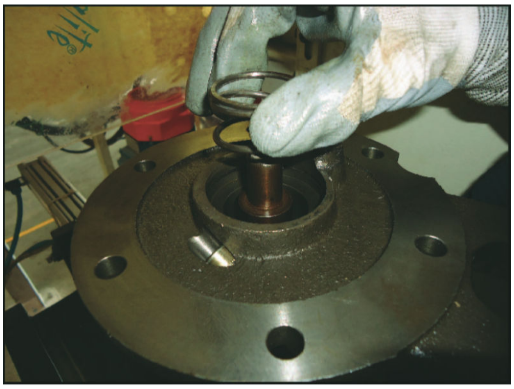
9. Place the side shift cover housing on the tool



10. Place the spacer inside the side cover housing

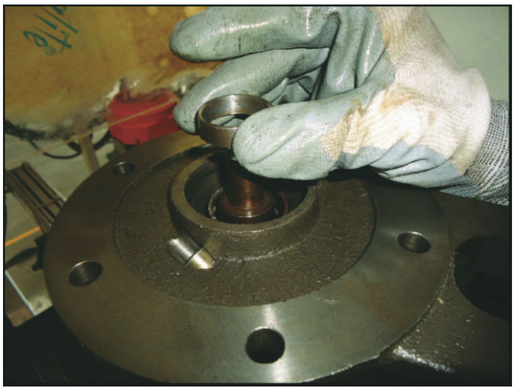


11. Place the spring



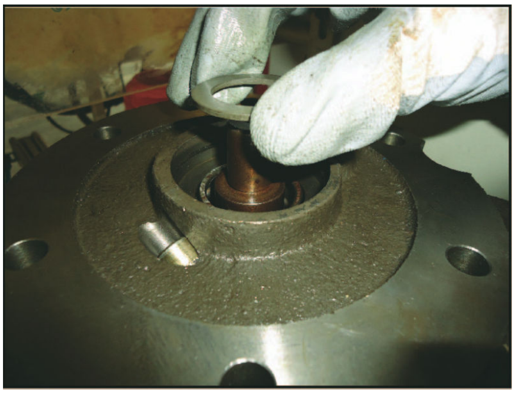
12. Place the collar

NOTE: The collar to be placed inside the spring



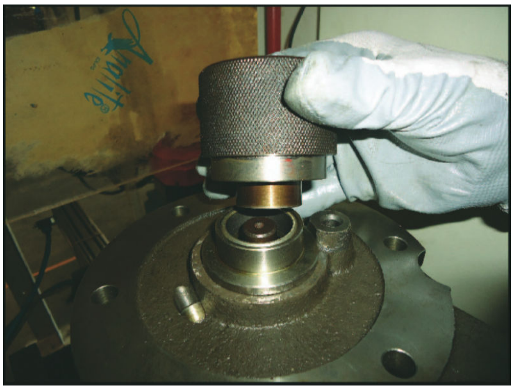
Refitment

13. Assemble the washer over the spring

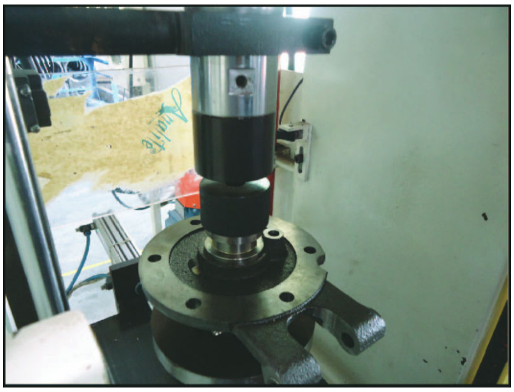


14. Assemble the bush on the side cover housing and place the service tool (SER3000007) as shown

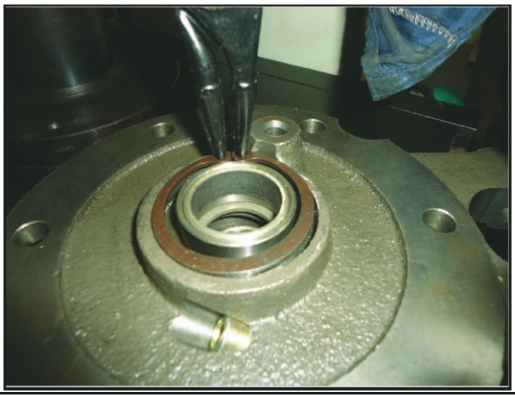
NOTE : Refer page no:45 for service tool details



15. Press the assembly using a hand press

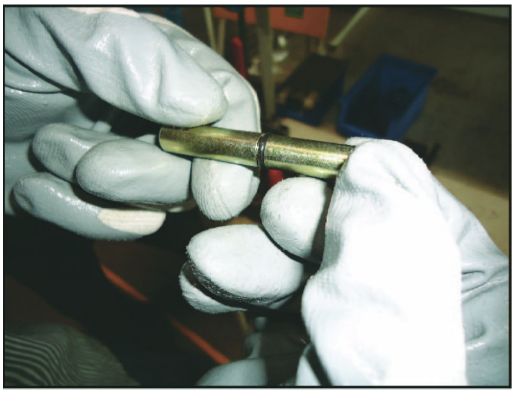


16. Secure the assembly with circlip



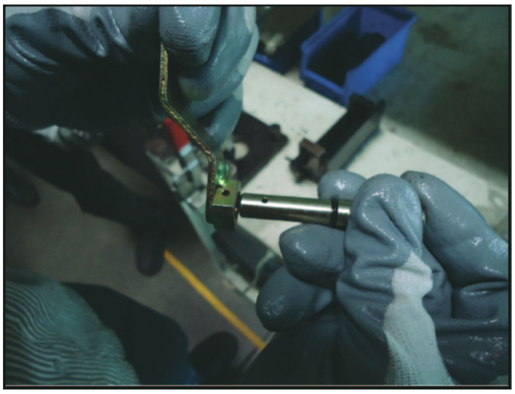
Refitment

17. Assemble the O ring on the repnse cover shaft



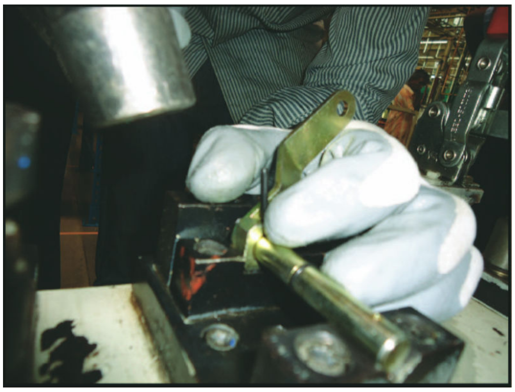
18. Assemble the response cover shaft with response lever

NOTE: Match the holes of response cover shaft and response lever

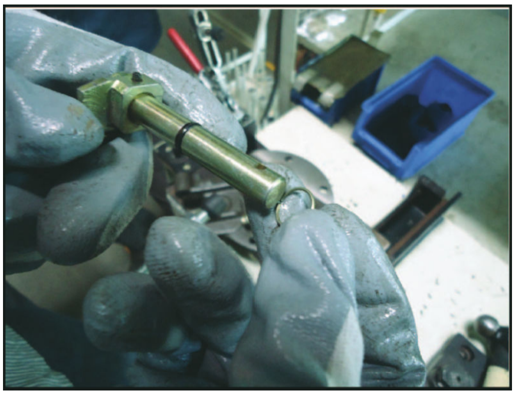


19. Place the assembly in a suitable vice

20. Secure the responsed cover shaft with response lever using a spirol pin

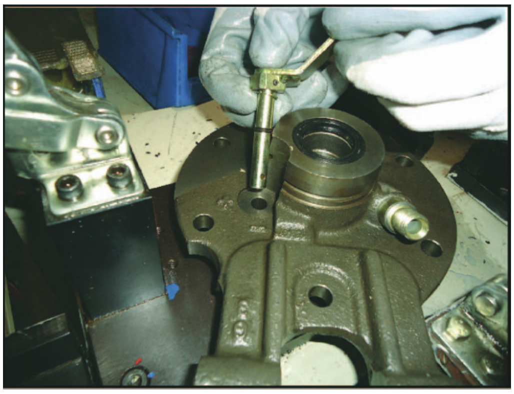


21. Assemble the ring with the response assembly



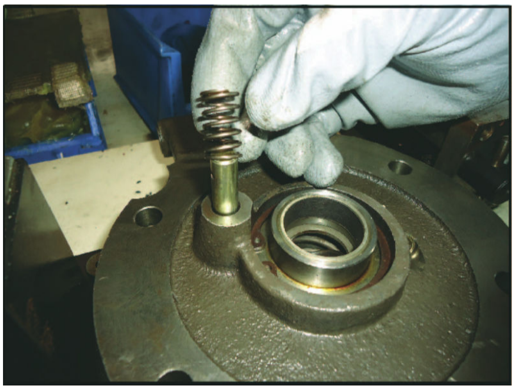
Refitment

22. Place the side cover housing in a suitable vice
23. Assemble the resonse lever assembly with side cover housing and hammer using a mallet

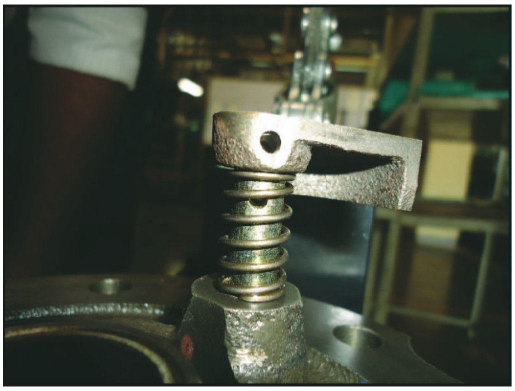


24. Turn the side cover housing and place in a suitable vice

25. Assemble the spring on the response cover shaft



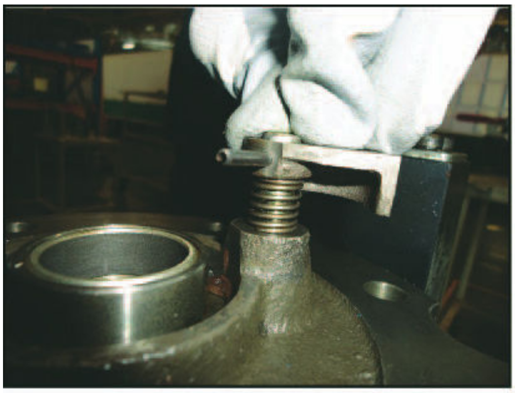
26. Assemble the cam on the response cover shaft



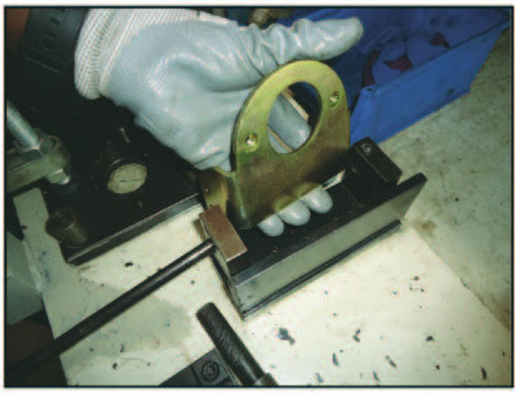
Refitment

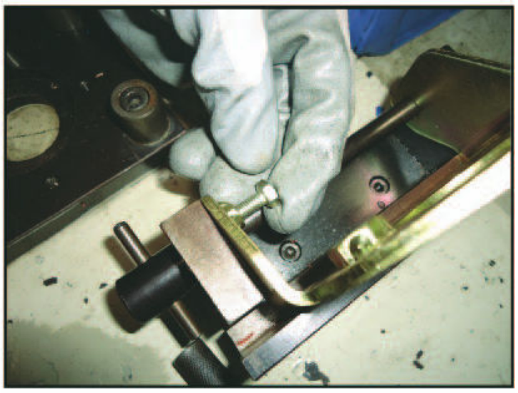
27. Align the hole in the cam with hole in response cover shaft by applying little force on the cam

28. secure using a spirol pin

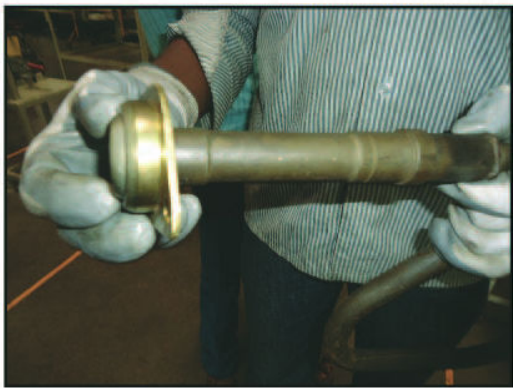


29. Place the pivot plate in a suitable vice and secure it properly



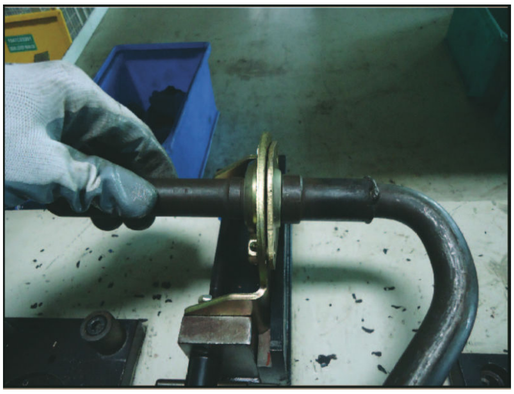


30. Assemble the ball & housing assembly with gear shift lever

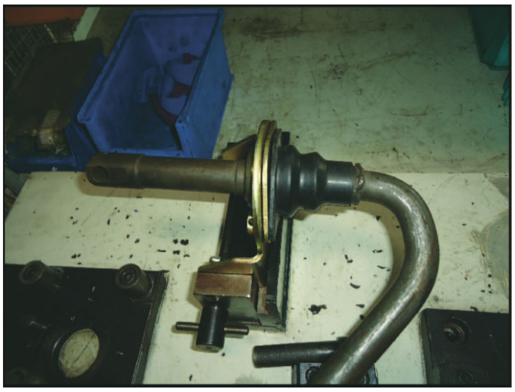


Refitment

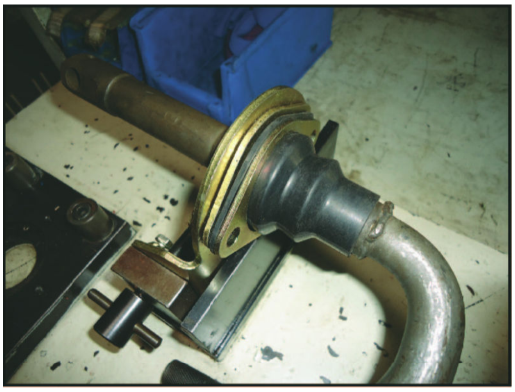
31. Assemble the gear shift lever with the pivot plate



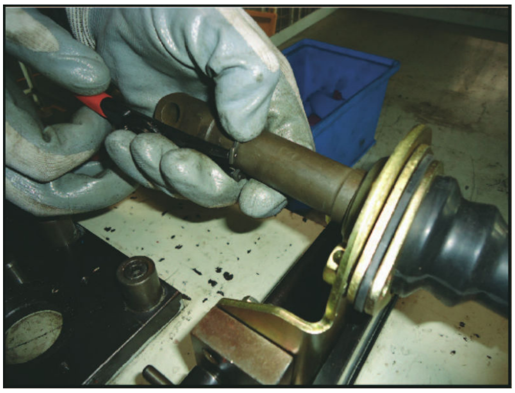
32. Assemble the rubber boot with the gear shift lever



33. Assemble the clamp plate with gear shift lever

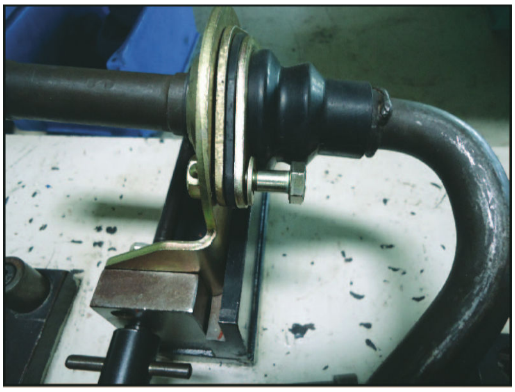


34. Secure the gear shift lever with pivot plate using a retaining ring.

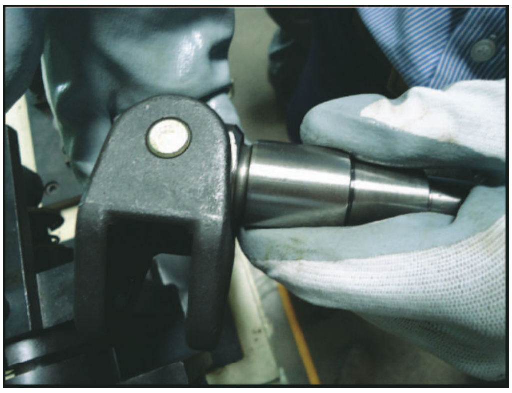


Refitment

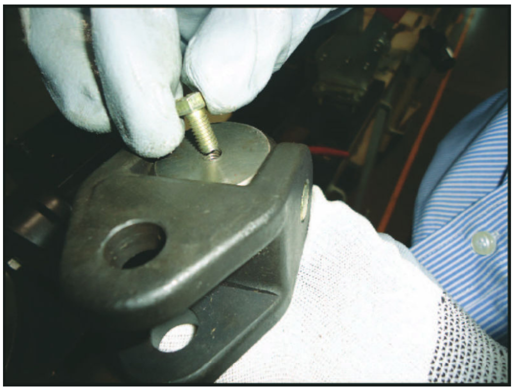
35. Secure the gear shift lever assembly with pivot plate using two bolts



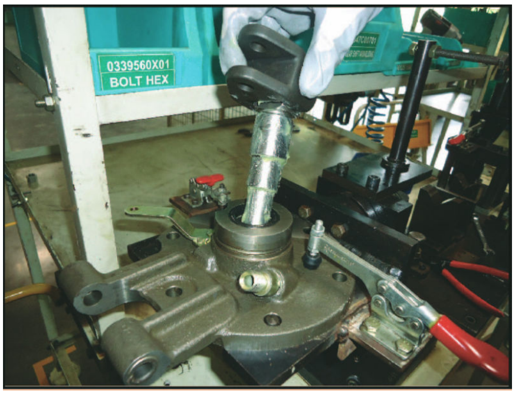
36. Align side shift with synchro pivot block and secure using a solid pin



37. secure the solid pin with a hex bolt



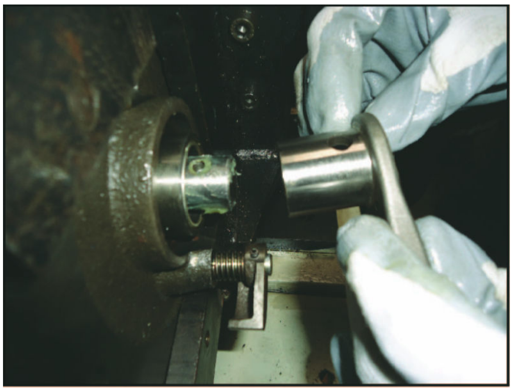
38. Place the side cover housing on a suitable vice
39. Apply grease on the side shift shaft
40. Position the side shift shaft assembly with the side cover housing



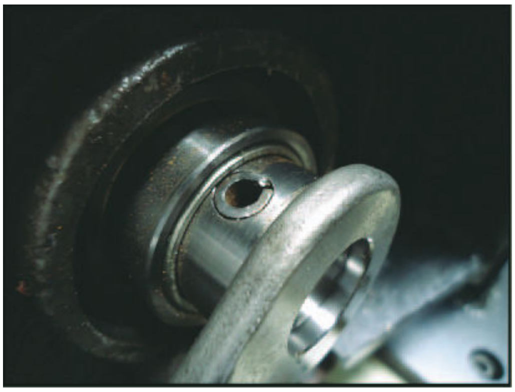
Refitment

41. Place the side cover housing on a suitable vice

42. On the rear side of the side cover housing, assemble the selector pawl with the side shift shaft

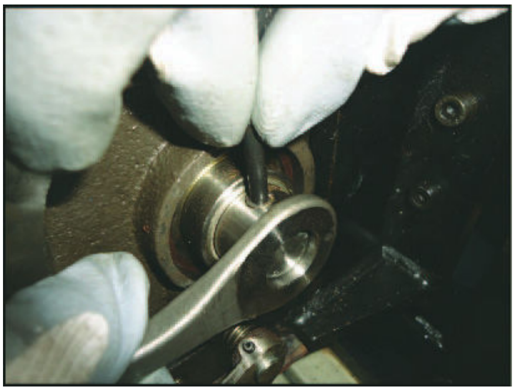


43. Align the holes of selector pawl and side shift housing and secure using a spirol pin

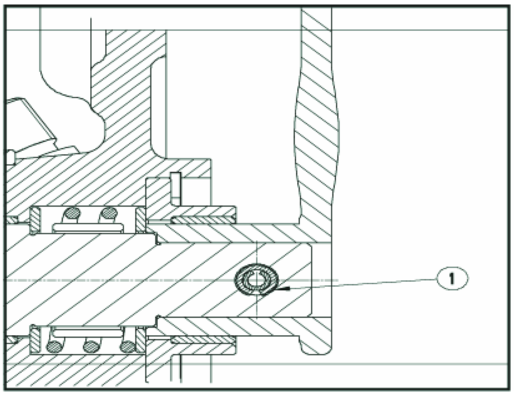


44. Double secure the assembly with another spirol pin which have smaller diameter than the previous.

NOTE: Ends of the both spirol pin should be placed diametrically opposite to each other



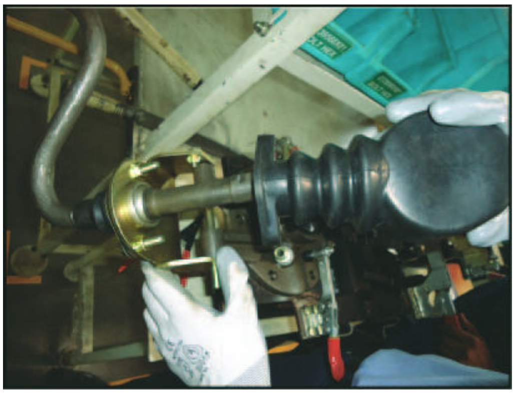
45. Spring dowel to be assembled as shown



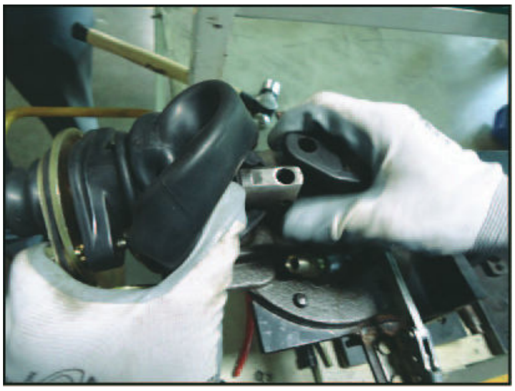
Refitment

46. Assemble the rubber boot with gear shift lever assembly

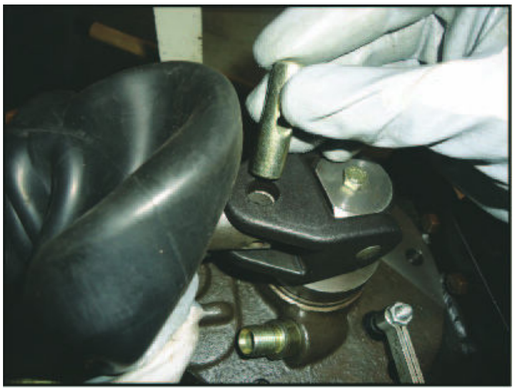
47. Secure the assembly using bolt & nut



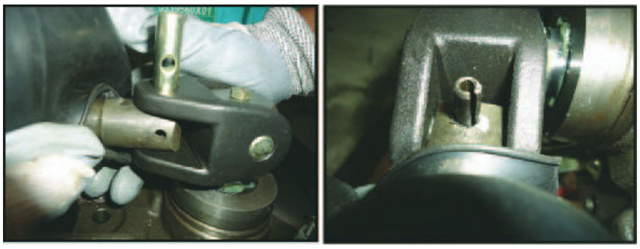
48. Assemble the gear shift assembly with side cover housing assembly by aligning the holes of gear shift lever and synchro block



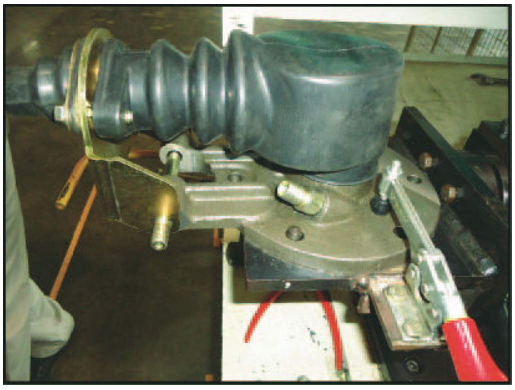
49. Secure using a solid pin



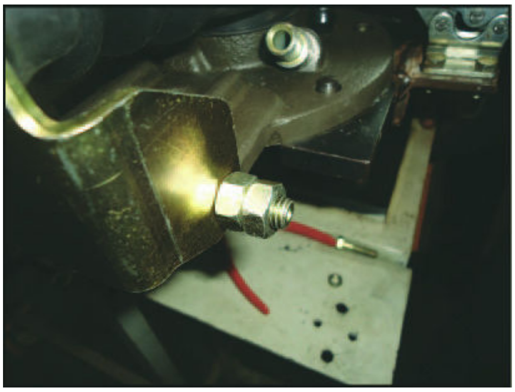
50. Align the hole of solid pin with gear shift lever and secure using a spirol pin

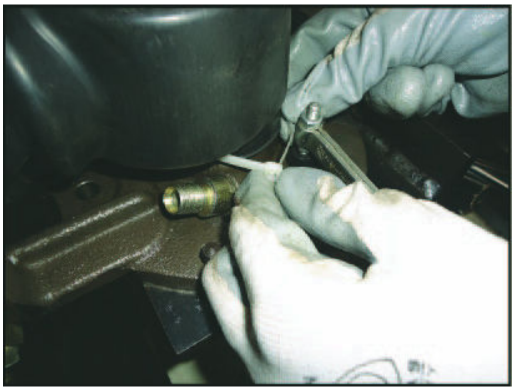


Refitment



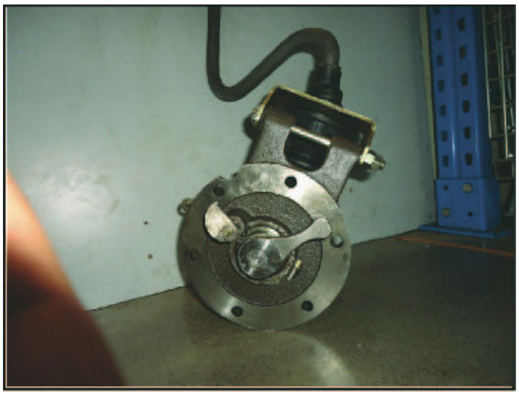
51. Fix the pivot plate with side cover housing using pin assembly
52. Secure with two bolts





53. Secure the rubber boot using a plastic strap
54. Tighten all the fastners

55. Assemble the Side shift sub assembly to the tractor



PLANETARY LEVER (HIGH-LOW GEAR LEVER)

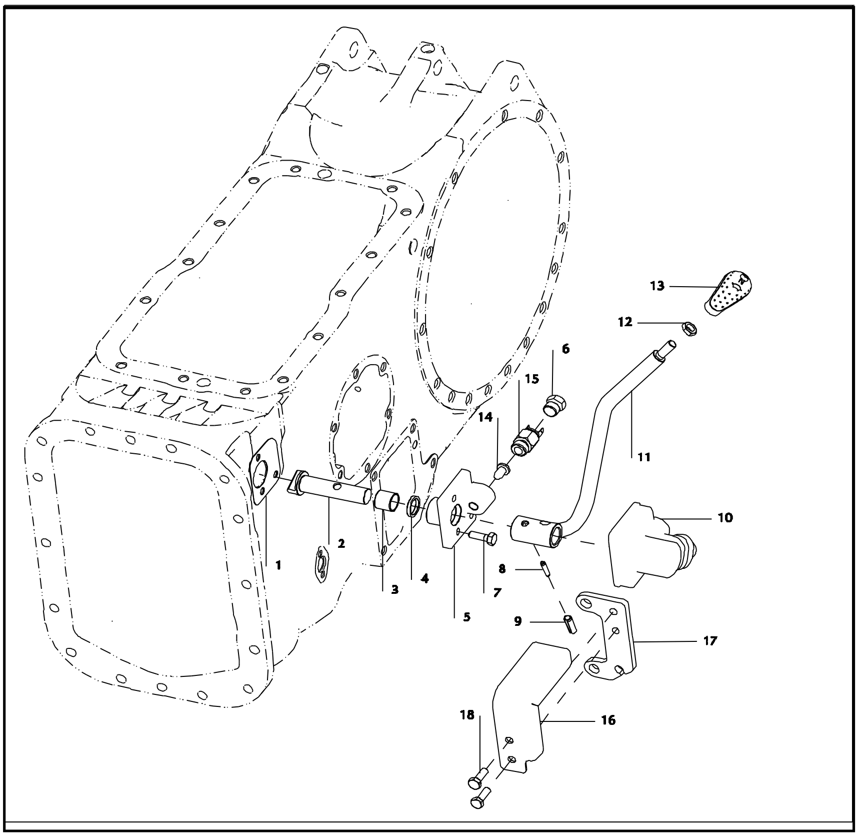


Fig 9

Removal and refitment

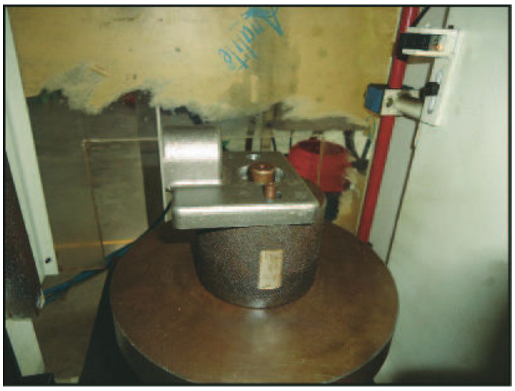
Removal

1. Park the vehicle on level ground and apply parking brake.
2. Pull the hood latch cable and lift the hood.
3. Disconnect the battery terminals
4. Remove the LH platform from the tractor, see operation 5.16 Foot step (page 5A - 14) .
5. Ensure planetary lever in neutral position.
6. Remove the knob(13) and nut(12)
7. Disconnect electrical connection from nuetral safety switch.
8. Remove plug(6),
9. Remove the nuetral safety(15) and ejector pin(14)-(FOR 8x2 ONLY)
10. Slightly adjust the rubber boot(10) and remove 3 precoated sealant screw.
11. Remove the planetary lever assembly from centre housing.
12. Remove the boot(10),spring pin(9)(8) and lever(11).
13. Remove the shaft(2),bush(3),oil seal (4) from housing planetary(5).

Refitment

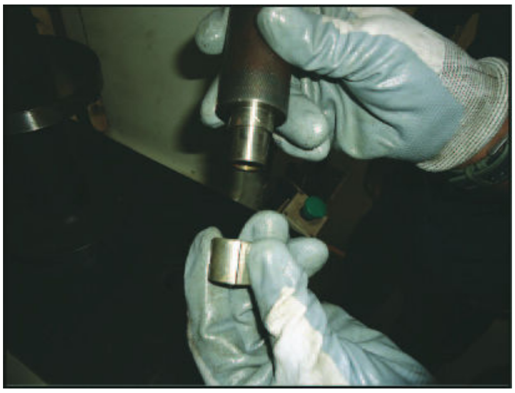
1. Place the planetary housing on the service tool (SER3000007)

NOTE : Refer page no:45 for service tool details

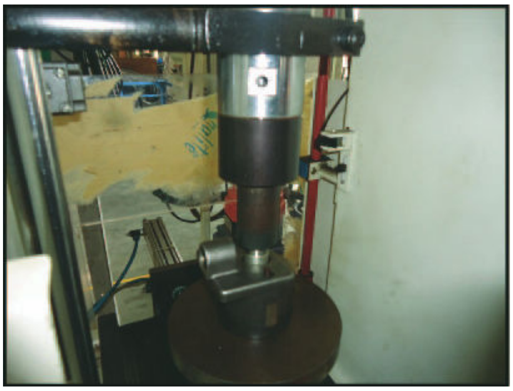


2. Place the bush on the service tool (SER3000007)

NOTE : Refer page no:45 for service tool details



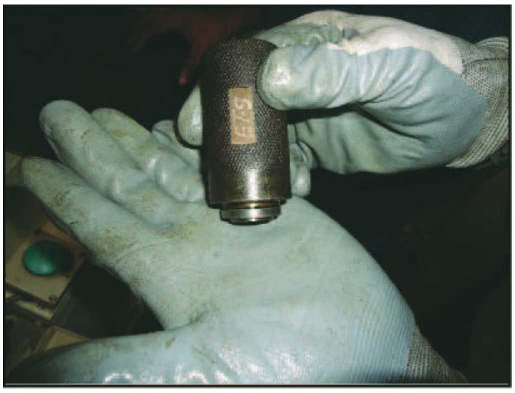
3. Press the bush to the planetary housing using hand press



4. Place the seal in the service tool (SER3000007)

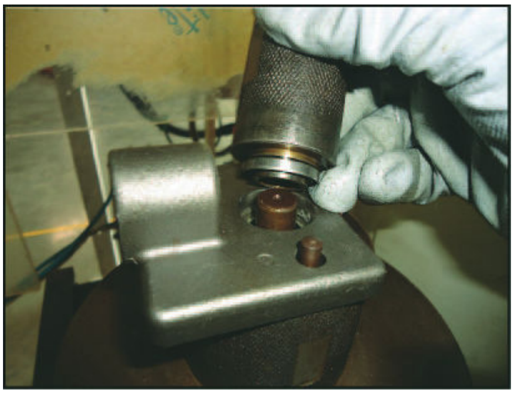
NOTE: The lip of seal to be faced upside

NOTE : Refer page no:45 for service tool details

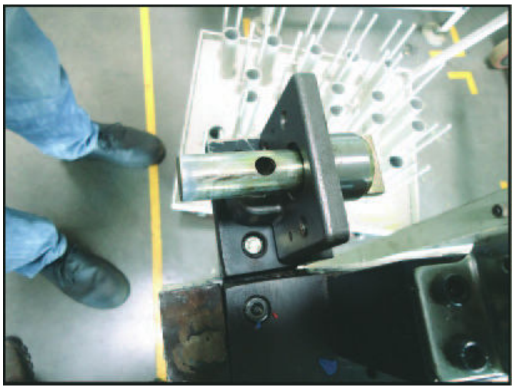


Refitment

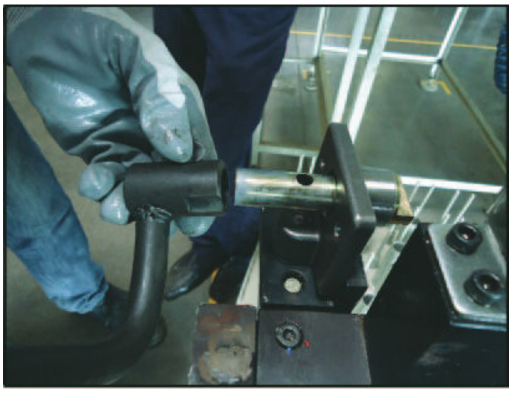
5. Press the seal in the planetary housing using hand press



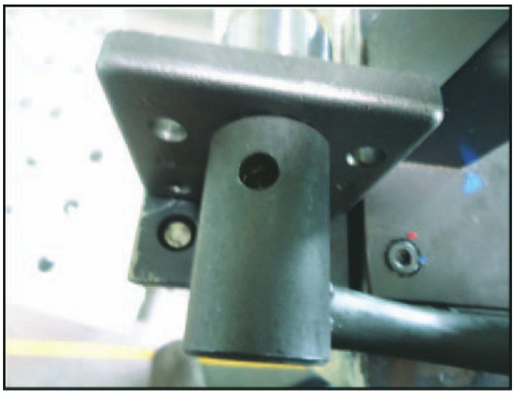
6. Place the planetary lever shaft inside the planetary housing



7. Assemble the planetary shift lever with shaft planetary lever



Refitment



8. Align the hole of planetary shift lever and shaft planetary lever

9. Secure using a spirol pin
10. Assemble the planetary lever sub assembly to the tractor

9B.5 SHUTTLE CONTROL LEVER

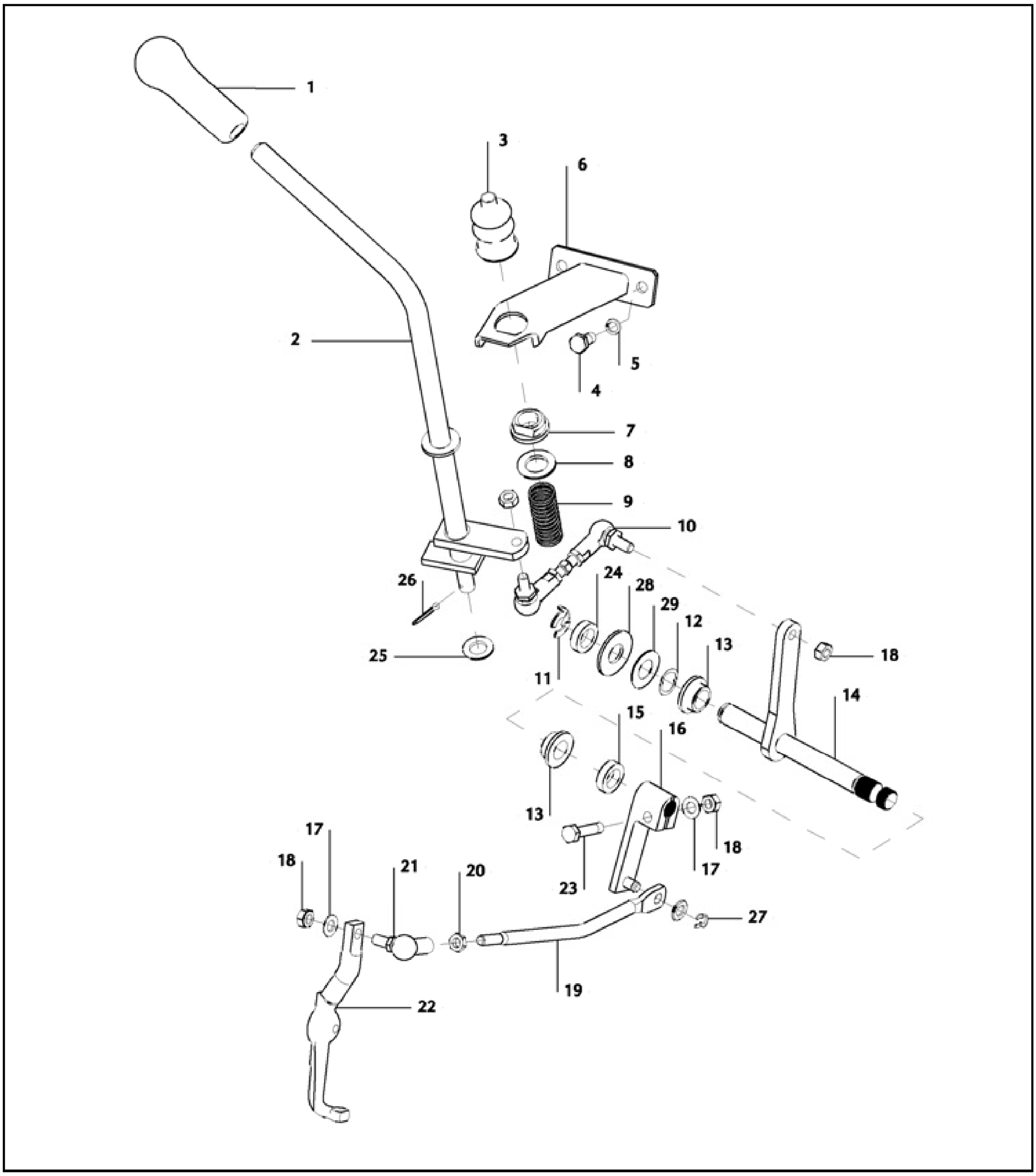

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Fig 10

9B.6 FORWARD/REVERSE (SHUTTLE) CONTROL LEVER

Overhaul

Dis-assembly

1. Remove the lower instrument panel. Gear lever
2. Remove hand grip from the lever(Item 1 in fig 3).
3. Unscrew and remove the hand grip.
4. Remove the nut securing the upper link to the gear lever (item 9,12 in fig 3).
5. Remove the Split from the base of the gear lever (Item 10 in fig 3).
6. Lift the gear lever up out of its bracket and then draw the lever downwards through the upper instrument panel (item 3 in fig 3).
7. Remove the plastic cover from the lever (item 5 in fig 3).
8. Remove the bearing , washer and spring (item 6,7,8 in fig 3).

Cross-shaft

9. Remove the nut retaining the lower link to the gearbox (item 9, 28 in fig 3).
10. Remove the spring clip, washer and lower link (Item 33,34,28 in fig 3).
11. Disconnect the hand throttle control cable.
12. Remove the two bolts securing the throttle control bracket and move it to one side sothat access can be made to the cross shaft.
13. Remove the nut and bolt and slide the lever off the shaft (Item 9, 23 in fig 3).
14. Remove the washer and bush (Item 19,20 in fig 3).
15. Remove the spring clip and bush (item 17,7,35,18,19 in fig 3).
16. Slide the cross-shaft to the right and by tilting it work it up out of the orbitrol support bracket (item 27 in fig 3).
17. Remove the nut and upper link (item 9,12 in fig 3).

Re-assembly

18. Reverse procedures 1 to 17 except:

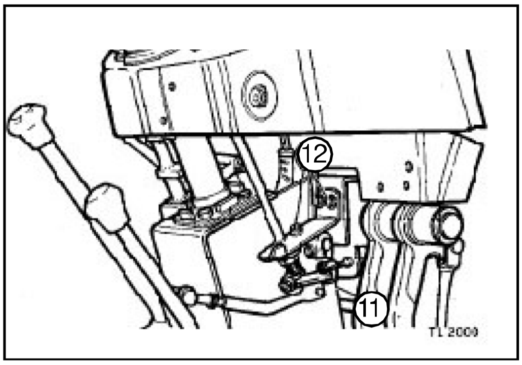

Fig 11

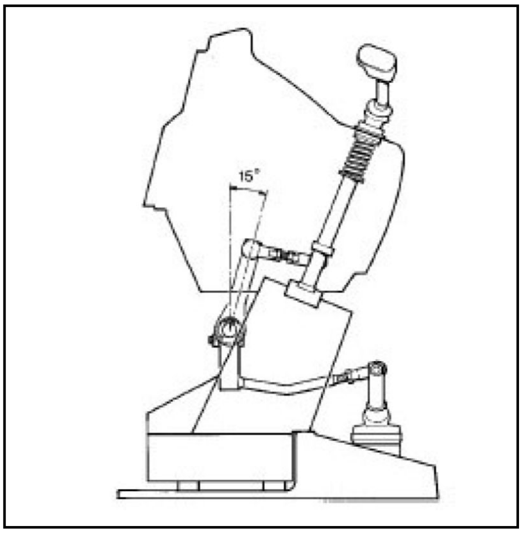

Fig 12

a. Lubricate all the shift lever bearings and thrust faces with general purpose grease when refitting.

b. Ensure that no electrical wiring or harness rubs or touches any moving part of the linkage.

c. Set the length of the upper link to 2.952 inch (75mm) between ball joint centres. Refit the cross shaft before assembly.

d. When refitting the cross-shaft and linkage the following points must be observed:

i. Put the gearbox forward/reverse (shuttle) lever in neutral.

ii.Connect up the upper link (12).

iii. Place the gearbox lever in neutral.

iv. Place the splined lever (24) onto the shaft so that there is a 15° angle between the two levers as shown in the illustration.

v. Make any adjustments to the lower link.

9B.7 SELECTOR RAILS AND FORK - CENTER SHIFT

Removal and refitment

Special Tools:

MF.414A	Centralising pin and locating peg

Removal

WARNING: Beware of sharp edges around the top of the gearbox case.

1. Split the tractor between the gearbox and the spacer housing or the centre housing and remove the gearbox,
2. Remove the gearbox top cover.
3. Remove all the locking wires and discard.
4. Remove the bolts, ball, spacer, and stop plate of the gear shift interlock mechanism.
5. Lift out the detent springs and plungers.
6. Loosen the locking screws.
7. Slide the 3rd/4th rail rearwards out of the housing.

   NOTE: When removing the selector rails, retain the gear lever selector jaws.
8. Loosen the locking screw.
9. Slide the 1st/2nd rail rearwards out of the housing and lift out the selector jaw.
10. Loosen the locking screw.
11. Slide the forward/reverse rail rearwards out of the housing.
12. Slide the high/low rail rearwards and remove the coupler.
13. Rotate the high/low rail through 90°.
14. Loosen the locking screw.
15. Slide the rail rearwards out of the casting.
16. Remove 1st/2nd and 3rd/4th selector forks.
17. Remove main input shaft, see operation 9B.8.
18. Remove the reverse idler assembly, see operation 9B.10 paragraph 9.
19. Remove the forward/reverse synchromesh selector fork.

Refitment

20. Reverse procedures 1 to 19 except:

a. Apply a few drops of oil to the selector rails before refitment.

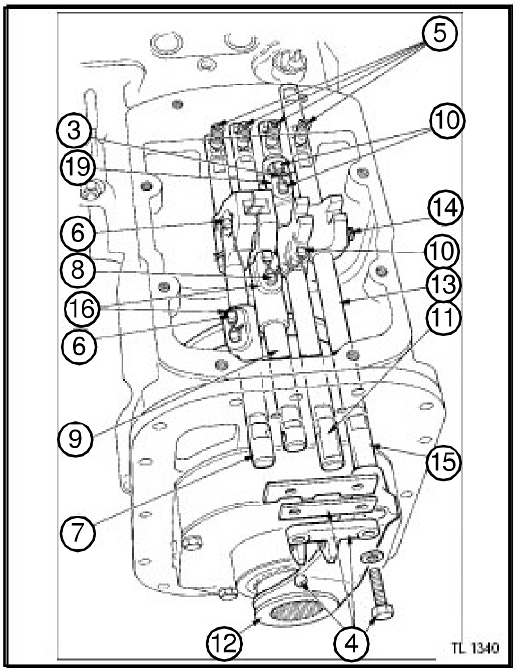

Fig 13

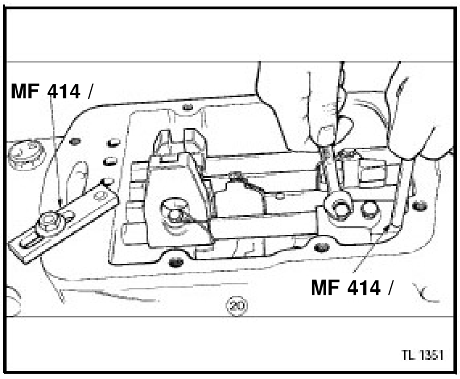

Fig 14

b. Set each synchromesh selector fork and rail to the neutral position. Lock the selector rail using the plate and bolt MF.414A/2 (part of tool MF.414A). Insert the centralising pin, MF.414A/1 into the hole on the top of the selector fork, lining it up with the corresponding hole in the sliding coupler and hub. Progressively lock up the two security screws on the selector fork to 32 lbs.ft. (44 Nm). Afterwards, check that the centralising pin MF.414A/1 can be removed freely.

c. Wire-lock all locking screws using new locking wire.

d. Tighten the high/low selector fork and selector block screws to a torque of 32.lbs.ft. (44 Nm)

e. On completion of the refitting procedure, place all the gears in the neutral position.

f. Torque the interlock mechanism retainingscrews (4) to 32 lbs.ft. (44 Nm).

9B.8 SELECTOR RAILS AND FORK - SIDE SHIFT

Removal and refitment

Special Tools:

MF.414A Centralising pin and locating peg

Removal

WARNING: Beware of sharp edges around the top of the gearbox case.

1. Split the tractor between the gearbox and the spacer housing or the centre housing and remove the gearbox,
2. Remove the gearbox top cover.
3. Remove all the locking wires and discard.
4. Remove the bolts, ball, spacer, and stop plate of the gear shift interlock mechanism.
5. Lift out the detent springs and plungers.
6. Loosen the locking screws.
7. Slide the 3rd/4th rail rearwards out of the housing.

   NOTE: When removing the selector rails, retain the gear lever selector jaws.
8. Loosen the locking screw.
9. Slide the 1st/2nd rail rearwards out of the housing and lift out the selector jaw.
10. Loosen the locking screw.
11. Slide the forward/reverse rail rearwards out of the housing.
12. Slide the high/low rail rearwards and remove the coupler.
13. Rotate the high/low rail through 90°.
14. Loosen the locking screw.
15. Slide the rail rearwards out of the casting.
16. Remove 1st/2nd and 3rd/4th selector forks.
17. Remove main input shaft, see operation 9B.8.
18. Remove the reverse idler assembly, see operation 9B.10 paragraph 9.
19. Remove the forward/reverse synchromesh selector fork.

Refitment

20. Reverse procedures 1 to 19 except:

a. Apply a few drops of oil to the selector rails before refitment.

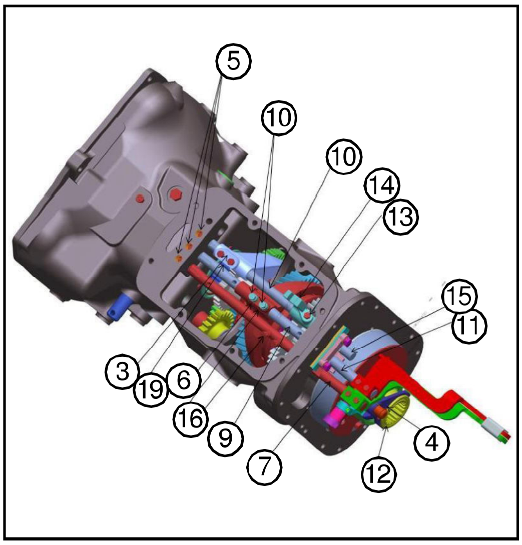

Fig 15

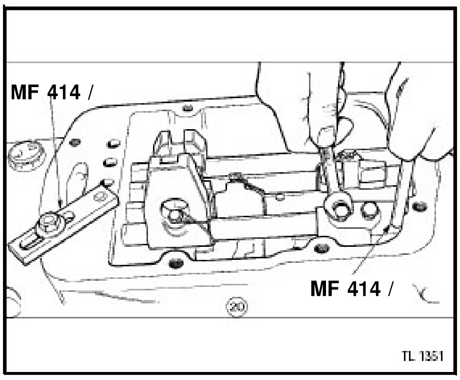

Fig 16

b. Set each synchromesh selector fork and rail to the neutral position. Lock the selector rail using the plate and bolt MF.414A/2 (part of tool MF.414A). Insert the centralising pin, MF.414A/1 into the hole on the top of the selector fork, lining it up with the corresponding hole in the sliding coupler and hub. Progressively lock up the two security screws on the selector fork to 32 lbs.ft. (44 Nm). Afterwards, check that the centralising pin MF.414A/1 can be removed freely.

c. Wire-lock all locking screws using new locking wire.

d. Tighten the high/low selector fork and selector block screws to a torque of 32.lbs.ft. (44 Nm)

e. On completion of the refitting procedure, place all the gears in the neutral position.

f. Torque the interlock mechanism retainingscrews (4) to 32 lbs.ft. (44 Nm).

9B.9 NORMAL-DUTY EPICYCLIC UNIT - CENTER SHIFT

Removal and refitment

Removal

1. Split the tractor between the gearbox and the spacer or centre housing,
2. Remove the locking wire and discard.
3. Remove the locking screw.
4. Remove the selector fork and coupling.
5. Remove the bolts.
6. Remove the complete assembly.

Refitment

7. Reverse procedures 1 to 6 except:

   a. Ensure that the front and rear thrust rings are correctly located before refitment.

   b. Ensure that the dowels are correctly located in the gearbox casing.

   c. Locate the cover plate with the cut out, to the bottom left hand corner.

   d. Fit a lockwasher to the lower right hand retaining bolt.

   e. Tighten the retaining bolts progressively and evenly to a torque of 32 lbs.ft. (44Nm)

   f. Tighten the selector fork lock screw to a torque of 32 lbs.ft (44 Nm).

   g. Wire lock all fixings affected by procedure 2 using new locking wire.

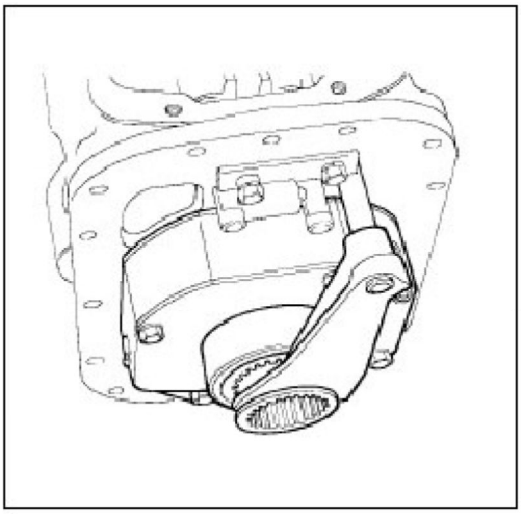

Fig 17

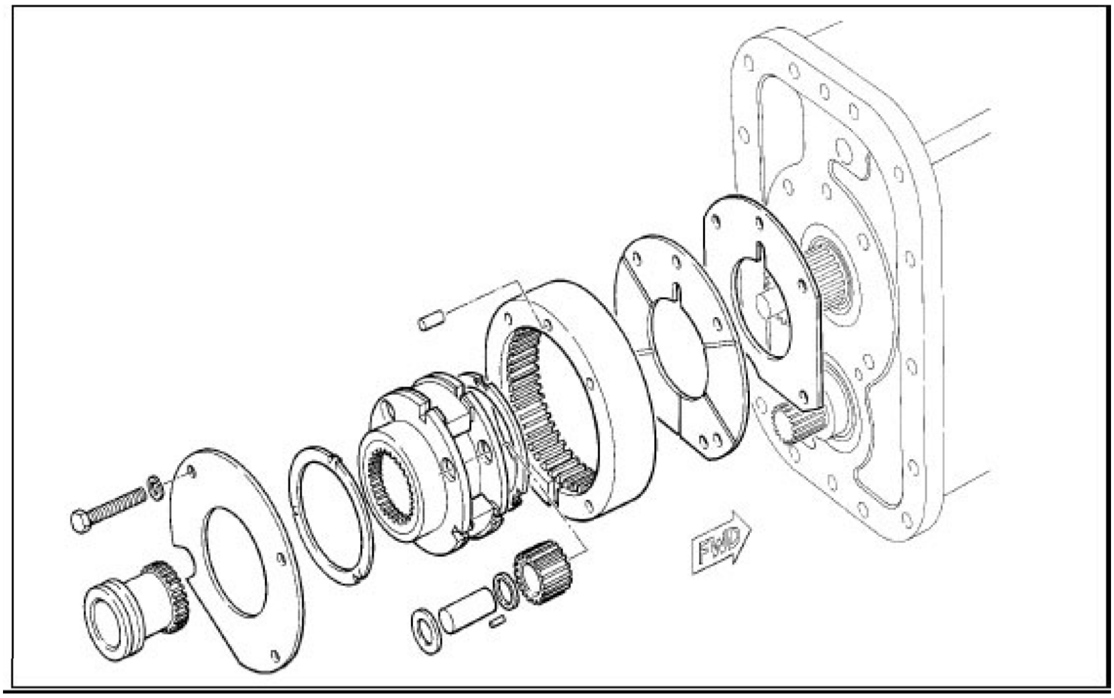

Fig 18

9B.10 NORMAL-DUTY EPICYCLIC UNIT - CENTER SHIFT

Overhaul

Dis-assembly

1. Remove the gearbox epicyclic unit, see operation 9B.6 .
2. Remove the rear plate.
3. Remove the rear thrust ring.
4. Remove the planetary pinion carrier.
5. Remove the front thrust ring.
6. Remove the shim.
7. Remove the front plate.
8. If necessary remove the two dowels from the ring gear.
9. Press each shaft out of planetary pinions and carrier.
10. Retain the three spacers, two thrust washers and needle roller bearings from each pinion.

Examination:

Clean and carefully examine all the components,especially those subject to movement, and replace any items that show signs of damage or wear.

Re-assembly

11. Replace the needle rollers in each pinion, a smear of petroleum jelly, NOT GREASE, will help to retain them. There are two rows of 27 rollers to each pinion.
12. A spacer is fitted between each row of needle roller bearings and at each end of the pinion.
13. Fit a thrust washer to each side of the pinions.
14. To assist assembly of the front and rear thrust rings on the planetary pinion carrier, smear them with petroleum jelly,NOT GREASE. Ensure that the tabs on the thrust rings locate in the pinion carrier cut-outs, and the brass faces are fitted away from the planetary pinion carrier.
15. The front and rear plates have oil grooves which must be fitted towards the planetary pinion carrier.
16. Only one shim is fitted.

9A.11 EPICYCLIC UNIT - SIDE SHIFT

Removal and Refitment

Special Tools:

SER / 054 : Tractor splitting stand.

Removal

1. Split the tractor between centre housing and transmission.
2. Remove the 4 mounting bolts of ring gear. (Item 1 in Fig 17).
3. Remove the circlip (Item 23 in Fig. 18).
4. Remove the plunger (Item 21 in Fig. 18), Fork-planetary (Item 22 in Fig. 18), selector shaft planetary (Item 24 in Fig. 18) and Bush HI/LOW (Item 25 in Fig. 18).
5. Remove Selector-planetary (Item 27 in Fig. 18), Slotted pins (Items 28, 29 in Fig. 18).
6. Remove the Assembly bracket planetary (Item 26 in Fig. 18).
7. Remove the rear cover plate. (Item 14 in Fig 18).
8. Remove epicyclic carrier with rear and front thrust washers.

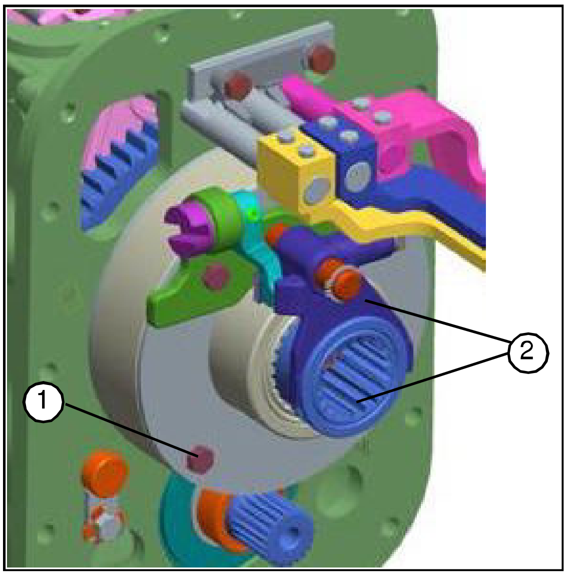

Fig. 19

9. Gently tap out the ring gear. (Item 5 in Fig. 18).
10. Remove the front cover plate and shim. (Item 1,3 in Fig. 18).
11. If necessary, remove the pin dowels from the ring gear. (Item 7 in Fig. 18).

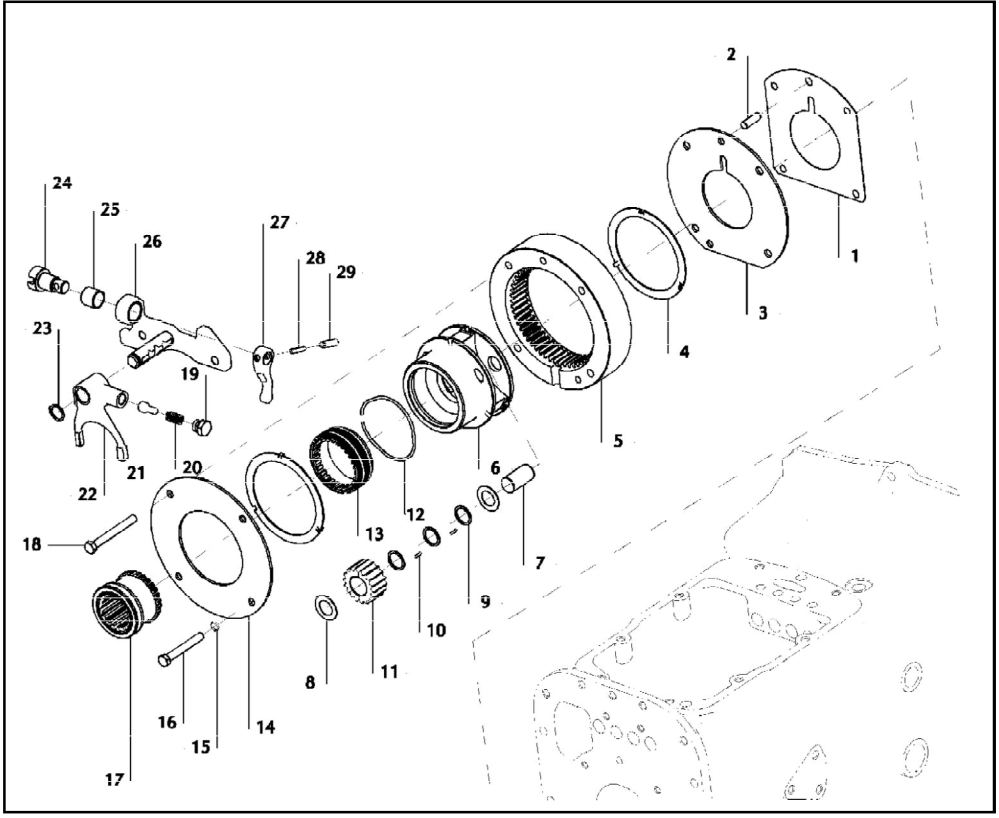

Fig. 20

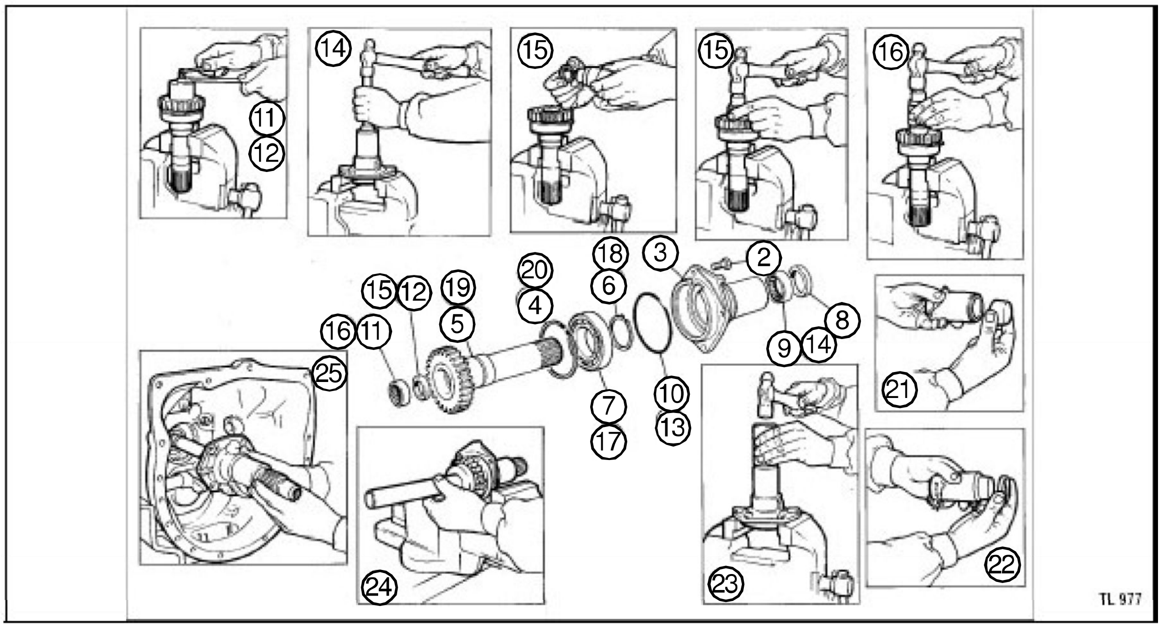

Fig 21

9B.12 INPUT SHAFTS AND HOUSING

Removal and refitment

Special Tools:

MF.255B	PTO input shaft oil seal replacer
MF.315 A	Needle roller bearing remover
MF.421	Needle roller bearing and seal replacer
MF.422A	Needle roller bearing and seal remover.
MF.177A	Input shaft seal sleeve

Removal

1. Remove the clutch release mechanism,see operation 9A.6 .
2. Remove the four bolts.
3. Withdraw the input housing complete leaving the main input shaft in position.
4. Remove the large internal circlip.
5. Push the PTO input shaft, complete with bearing, rearwards out of the housing.
6. If necessary remove the circlip.
7. If necessary press the bearing off the shaft.
8. Lever the seal out of the front of the housing.
9. Using MF.315A, drive the needle roller bearing from the front of the housing.
10. Remove the 'O' ring from the housing.
11. Using MF.422A, carefully remove the needle roller bearing from the inside of the PTO input shaft.
12. Using MF.422A, remove the oil seal from the PTO input shaft.

Refitment

13. Fit a new 'O' ring into the housing.
14. Using MF.315A, replace the needle roller bearing in the housing.
15. Using MF.421, fit a new seal into the input shaft with the lip of the seal facing the tool.
16. Using MF.421, refit the needle roller bearing into the input shaft with the round end of the cage to the bottom of the recess.
17. Refit the bearing onto the outside of the shaft with the shield towards the gear teeth.
18. Refit the circlip. (Check that it is properly seated.)
19. Refit the PTO input shaft and bearing into the input housing.
20. Refit the circlip. (Check that it is properly seated.)
21. Ensure that the nylon cone is in place on the seal replacer MF. 255B.
22. Place the seal over the cone and onto the tool with the seal lip facing away from the tool and remove the nylon cone.
23. Place the tool over the PTO input shaft and tap the seal into place.
24. Place seal protector sleeve MF.177A over the main input shaft on the gear box.
25. Carefully refit the input housing over the input shaft and withdraw the protector sleeve when the housing is in place.
26. Reverse procedures 2 to 7, except:

    a. Use petroleum jelly, NOT GREASE, to lubricate all seals and the needle roller bearing when refitting.

    b. Lightly coat the bolt thread with Hylomar sealant when refitting and tighten the bolts to a torque of 43 lbs.ft. (58 Nm).
27. Refit the clutch release mechanism, see operation 9A.6.

9B.13 PTO DRIVE SHAFT FRONT BEARING

Removal and refitment

Special Tools:

MF.218B PTO Drive Shaft Puller.

Removal

1. Remove the clutch release mechanism, see operation 9A.6.
2. Remove the four bolts and washers.
3. Remove the cover plate.
4. Remove the external circlip and washer.
5. Screw two 3/8 UNC x 3 inch (part of MF.218B) bolts into the bearing housing and tighten them evenly to draw the housing from the case and shaft.
6. Remove the housing.
7. Remove and discard the circlip.
8. Press out the bearing.
9. Remove and discard the ‘O’ ring.
10. Remove and discard the gasket.
11. If the gearbox has been removed and it is necessary to remove the PTO shaft, insert a 7/16 inch UNF bolt approximately 3-4 inch long into the shaft to protect it, drive the shaft out of the PTO constant mesh gear.

Refitment

12. Lightly coat the new gasket with Hylomar sealant.
13. Using MF.218B, refit the bearing and housing assembly.
14. Check that the PTO drive shaft splines locate with those in the PTO constant mesh gear, if the shaft has been removed.
15. Screw the centre screw into the end of the PTO shaft with the aid of a 9/16 inch across flats spanner.
16. Locate the bearing and housing assembly on the end of the PTO shaft and to the housing with the two long bolts provided with MF.218B through the unthreaded holes.
17. Place the adaptor onto the centre screw with the hollow face against the bearing.
18. Place the washer on the centre screw and put on the nut.

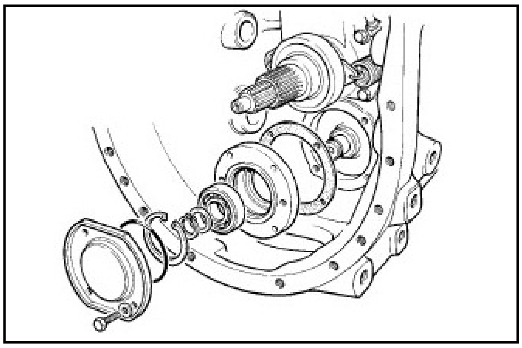

Fig 22

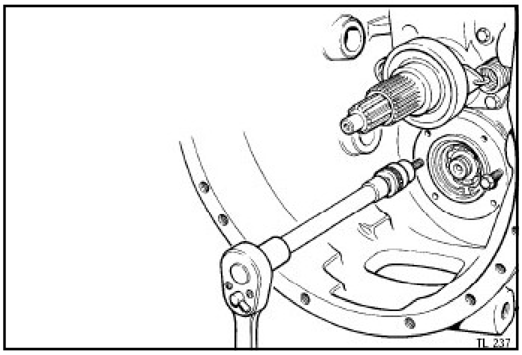

Fig 23

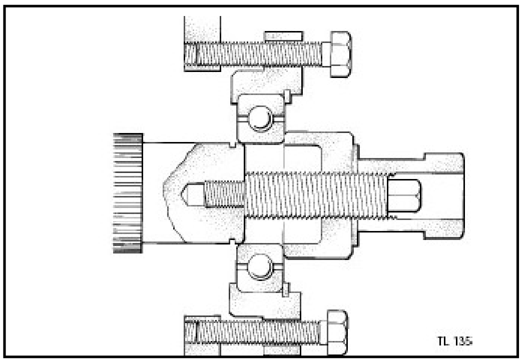

Fig 24

19. Tighten the nut with a 1 1/8 inch across flats spanner until the housing is pushed home and the PTO shaft is drawn through the ball bearing sufficiently to enable the washer and circlip to be fitted.
20. Fit a new circlip and washer.
21. Replace the cover ensuring that a new ‘O’ ring is fitted.
22. Lightly coat the securing bolt threads with Hylomar sealant.
23. Tighten the bolts to a torque of 43 lbs.ft. (58 Nm).

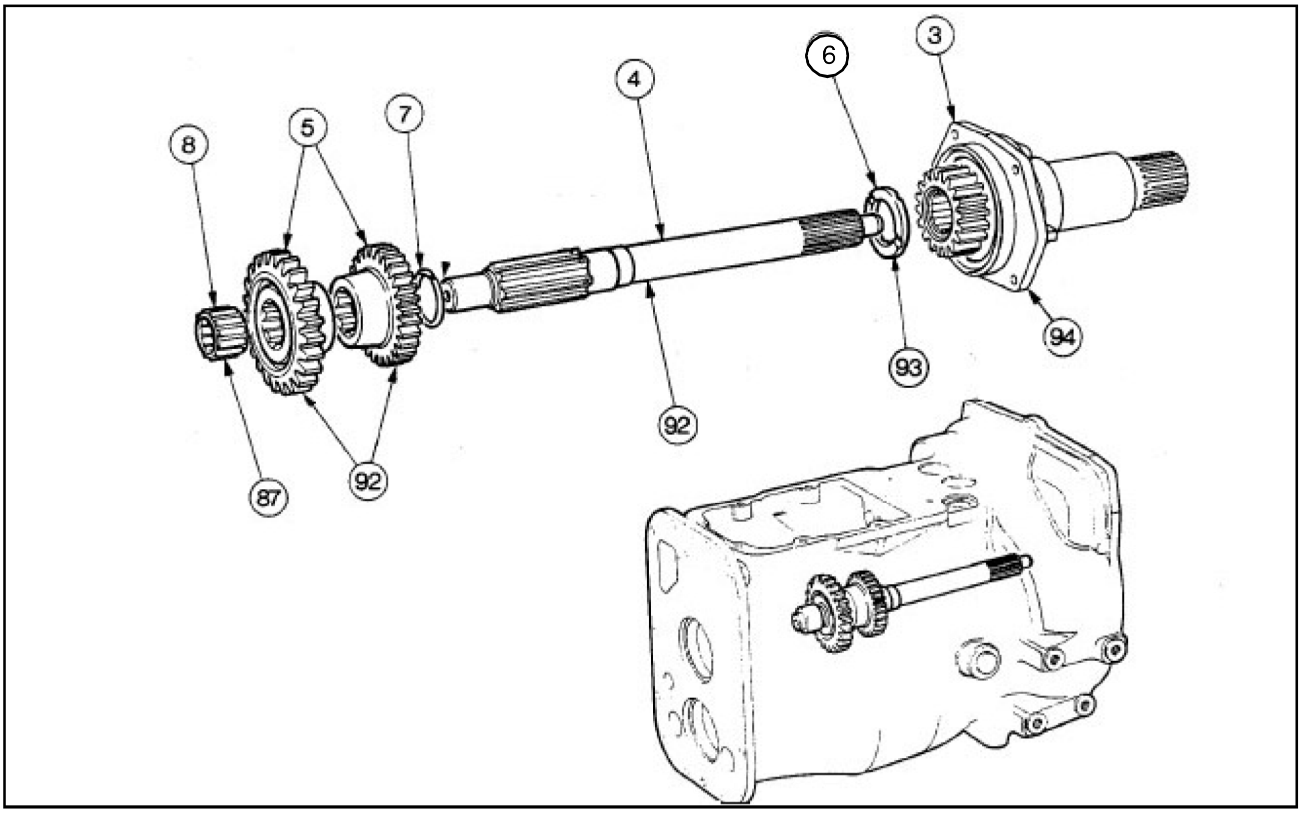

Fig 25

9B.14 LAYSHAFT, MAINSHAFT, PTO SHAFT AND GEARS

Overhaul

Special Tools:

MF.415	Synchromesh hub assembly tool
MS.550	Drive handle

Dis-assembly

With the gearbox removed from the tractor:

1. Remove the clutch cross-shaft and lever, see operation 9A.6 .
2. Remove the selector rails and forks, see operation 9B.5 .

NOTE: *The layshaft selector fork cannot be removed at this stage. Input shafts and housing*

3. Remove the input shaft and housing, see operation 9B.8 .
4. Withdraw the main input shaft.
5. Lift out the forward and reverse constant mesh gears.
6. Remove the main thrust washer.
7. Remove the snap ring and thrust washer from the main input shaft, if necessary.

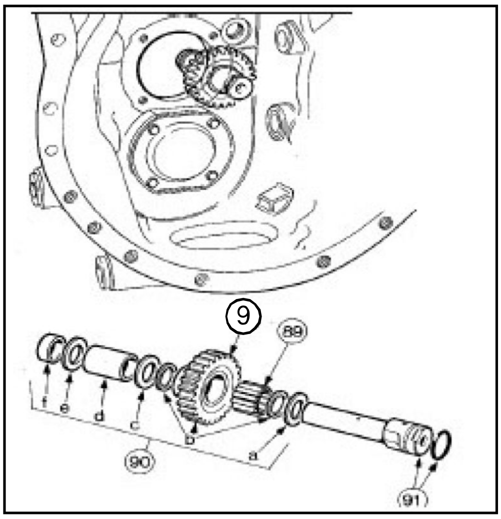

Fig 26

8. Remove the needle roller bearing from inside the main shaft.

Reverse Idler

9. Remove the reverse idler shaft by easing it out of the front of the gear box with a screw driver between the inner spacer and the casing, be careful, the idler gear contains loose needle roller bearings. Retain the components in a clean container.

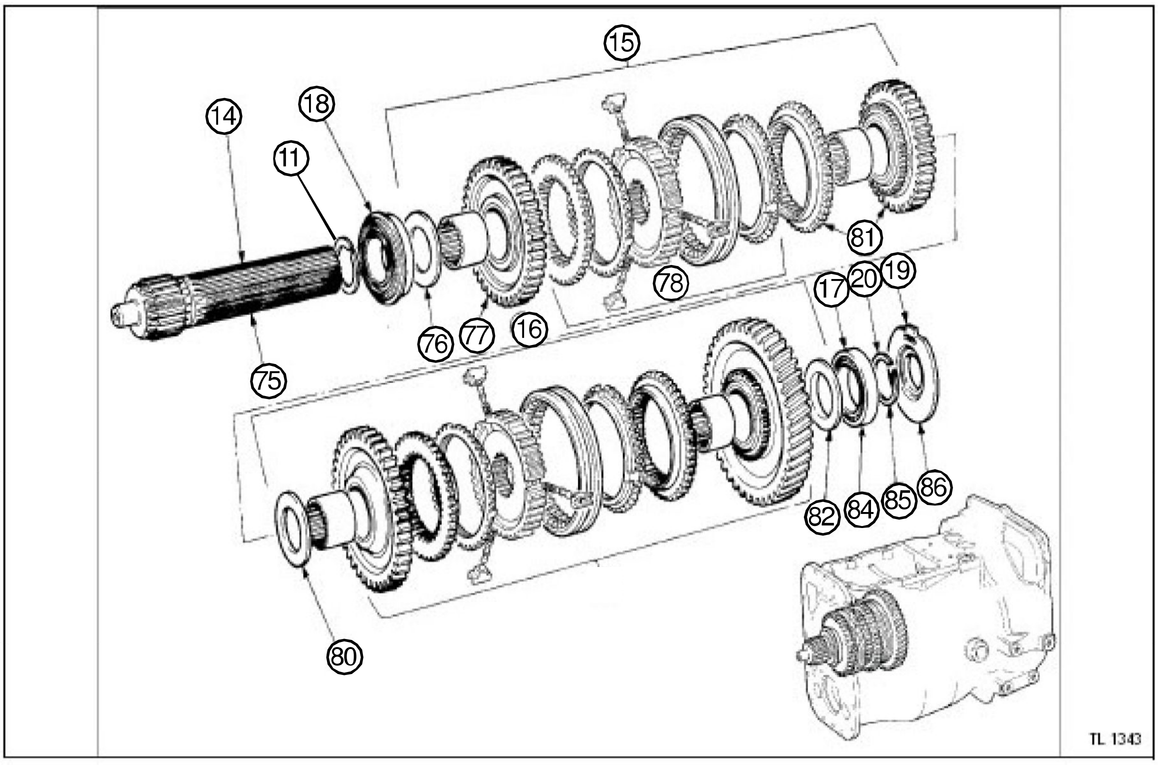
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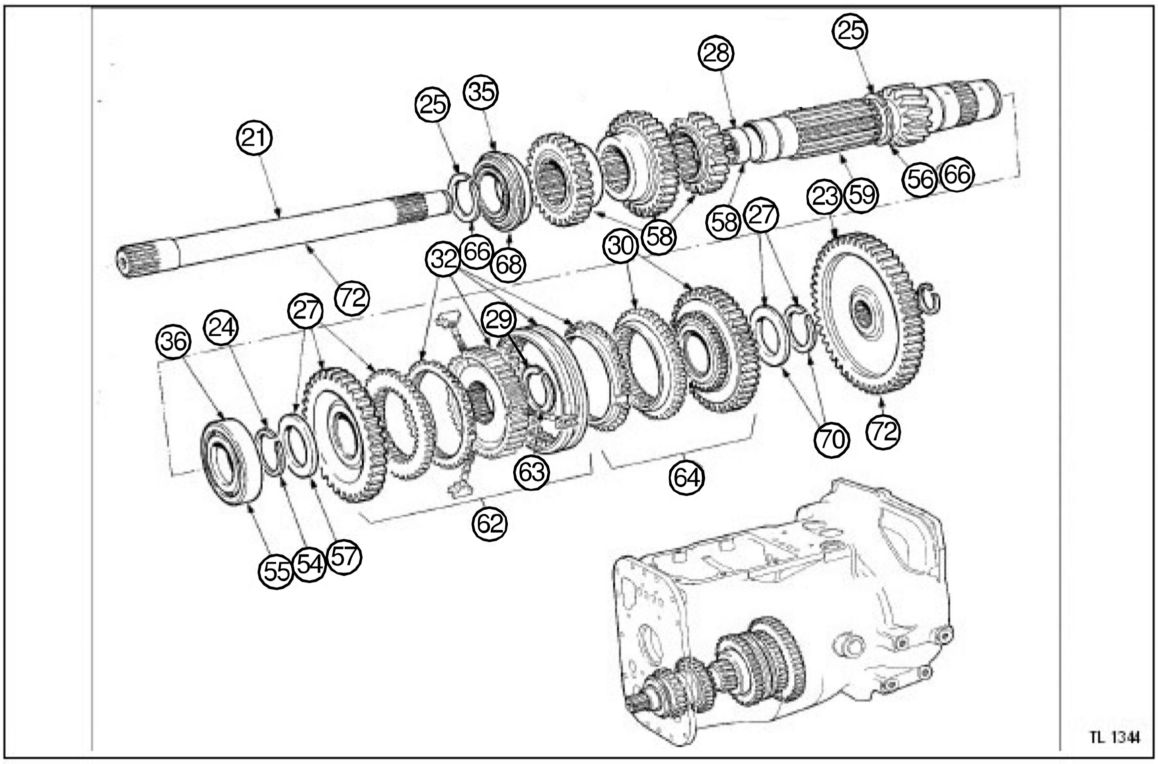
Fig 27 Main shaft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TL 1344

Fig 28 Lay shaft

Mainshaft

10. Lightly drive the front roller bearing to the rear with a punch to facilitate removal of the main shaft snap ring.
11. Remove the snap ring from the front of the main shaft.
12. Remove the epicyclic reduction unit from the rear of the gearbox, see operation 9B.6 .
13. Push the front main shaft bearing forward to give clearance to the 1st/2nd gear set assembly.
14. Pull the main shaft out of the gearbox to the rear.
15. Lift out the 1st gear and the measured thrust washer, then 2nd gear and the synchromesh hub.
16. Lift out the rear 3rd/4th gear set assembly and thrust washers.
17. Remove the front roller bearing from the gearbox case.
18. Press the rear ball bearing off the front of the shaft.

Layshaft

19. Remove the PTO drive shaft front bearing cover.
20. Remove the the PTO shaft circlip and thrust washer.
21. Screw a 7/16 inch UNF bolt approximately 3-4 inch long into the end of the PTO shaft. Drive the shaft out of the bearing.
22. Remove the PTO drive shaft front bearing, see operation 9B.9 .
23. Lift out the PTO constant mesh gear.
24. Remove the snap ring from the rear of the layshaft.
25. Carefully drive the layshaft forward to ease removal of the snap ring in front of the 2nd gear, move it to the un-splined portion of the shaft.
26. Remove the snap ring and thrust washer from the front of the layshaft and then drive the layshaft fully rearwards.
27. Slide the reverse constant mesh gear fully forward. Remove the circlip with a pair of right angled circlip pliers from the front of the synchromesh hub. Slide the circlip as far forward along the layshaft as possible.
28. Drive the layshaft rearwards so that roller bearing is in the rear section of the gearbox.Lift the reverse ratio gear out through the top of the gearbox.
29. Remove the circlip and the synchromesh hub assembly.
30. Remove the forward ratio gear and thrust washer.
31. Relocate the bearing in the centre web and drive the layshaft forward, remove it through the front of the gearbox.
32. Lift out the 2nd, 3rd and 4th gears.
33. Remove the snap ring.
34. Press the front layshaft bearing off the shaft.
35. Remove the rear bearing from the casing.
36. Remove the PTO rear support bearing.

Synchromesh hub assemblies:

37. Remove the two baulk rings.
38. Remove the drive hub complete with the coupler.
39. Wrap the hub and coupler in a cloth.
40. Remove the coupler, taking care not to lose springs, ball pins and pressure blocks.
41. Remove the three pressure blocks.
42. Remove the three ball pins.
43. Remove the three springs.
44. Thoroughly clean all the components and check their condition.
45. Using a feeler gauge, measure the clearance between the ring and the synchromesh cone on the gear at several points. The baulk ring must be correctly positioned on the synchromesh cone. If the clearance is less than 0.020 inch (0.5 mm), replace the baulk ring. If the clearance is checked with the gearbox assembled replace the baulk ring if the clearance is found to be less than 0.031 inch (0.8mm).

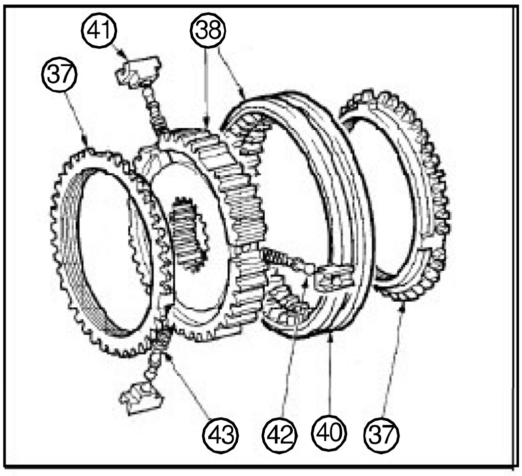

Fig 29

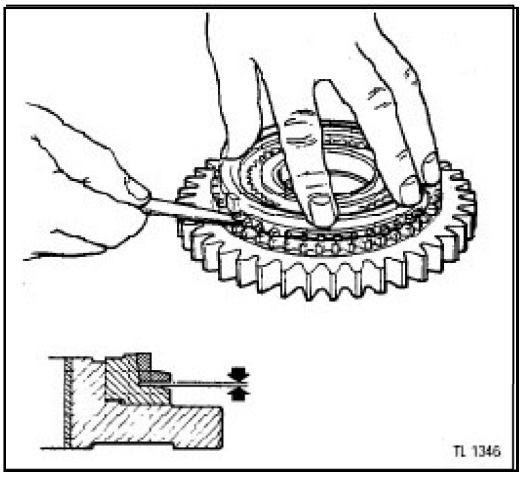

Fig 30

Examination

46. Clean and thoroughly inspect all parts for signs of wear or damage and renew if necessary. Renew all snap rings, when refitting ensure that they are correctly located in their grooves.

Re-assembly

Synchromesh hub assemblies

47. Reverse procedures 37 to 43.

48. On replacing the springs, ball pins and blocks into the coupler, special service tool MF. 415 and handle MS.550 must be used to locate the hub back in the coupler.

49. Place the hub on the work bench and insert the three springs, ball pins and pressure blocks.

50. Carefully place the hub assembly into the ring of MF.415 ensuring that hole 'A' in the hub is in line with the hole 'A' in the side of MF.415. Press the hub down into the tool compressing the pressure blocks, ball pins and springs.

51. Place the hub and tool over the coupler checking that the hole in the tool and hub aligns with the hole in coupler, also check that it is concentric.

    NOTE: *Ensure that the hole 'A' in the coupler is fitted in line with the hole in the hub, it is used to align the selector fork to the rail.*

52. Fit handle MS.550 to the round plate of MF.415 and use it to tap the hub into the coupler. Layshaft

53. Press the front roller bearing onto the shaft.

54. Fit the roller bearing circlip.

55. Fit the rear PTO shaft support bearing.

56. Place the circlip on the un-splined portion of the shaft.

57. Refit the thrust washer at the front of the shaft.

58. Place the 2nd (20T), 4th (29T) and 3rd (28T) gears in the bottom of the gearbox.

59. Pass the layshaft through the front of the gearbox so that the roller bearing is in the first section.

60. Fit the layshaft gears in the above order.

61. Drive the layshaft rearwards so that the roller bearing is in the rear section.

62. Refit the forward gear and synchromesh hub assembly.

63. Place the circlip on the un-splined portion of the shaft close up to the synchromesh hub.

64. Refit the reverse gear assembly.

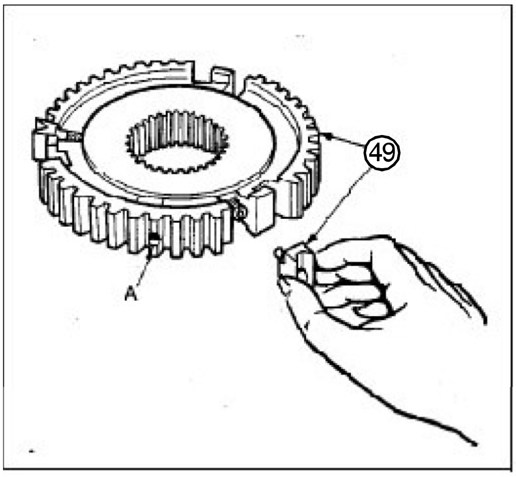

Fig 31

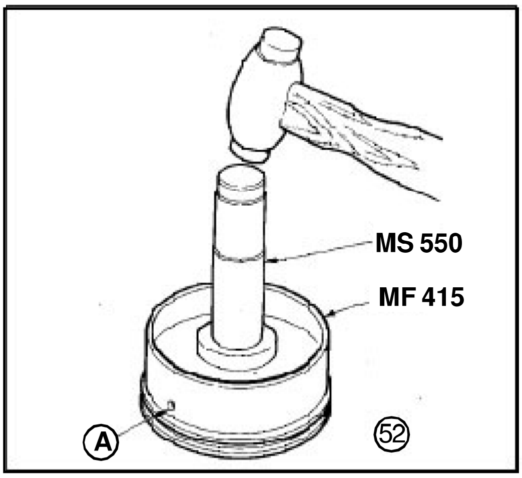

Fig 32

65. Enter the roller bearing into the centre web. Drive the layshaft forward holding the reverse gear set so that it pushes the circlip between the reverse gear and hub into its groove.

CAUTION: Check that the circlip between the reverse gear and the synchromesh hub is correctly seated in its groove.

66. Refit the circlip from the un-splined portion of the shaft into its groove in front of 2nd gear.

67. Place a block between the front of the layshaft and the gearbox casing in the front section.

68. Drive the rear roller bearing onto the end of the shaft and into the gearbox casing.

69. Remove the block and replace the rear snap ring.

70. Refit the thrust washer with the flat face towards the reverse gear and replace the snap ring.

71. Ensure that the shaft is fully forward and check that the layshaft turns freely.

72. Place the PTO constant mesh gear in the bottom of the gearbox and refit the PTO shaft from the rear of the gearbox.

73. Refit the PTO drive shaft front bearing, see operation 9B.9 .

Mainshaft

74. Assemble the mainshaft complete with all hubs, gears, bushes, bearing and thrust washers. Refit circlip. Measure the gap 'B' between the front bearing and the circlip. The gap (end float) should be between 0.080 mm and 0.30 mm. If your measurement falls outside the set limits, replace the calibrated thrust washer 'C', which sits between the bearing and first gear, with one of a choice of varying thickness thrust washers to achieve the desired end float. Calibrated shims part numbers and sizes are as follows:

Shim thickness		Part number
mm	inch	
4.14 - 4.19	0.162 - 0.164	1671 888 M2
4.39 - 4.44	0.172 - 0.174	1671 889 M2
4.62 - 4.67	0.181 - 0.183	1671 890 M2
4.85 - 4.90	0.190 - 0.192	1671 891 M2

75. Slide the mainshaft through the rear of the gearbox, progressively fitting in the following order:

76. Steel thrust washer.

77. 3rd gear (35T) with steel bush and synchromesh cone.

78. Synchromesh hub assembly and baulk ring.

79. 4th gear (40T) with steel bush and synchromesh cone.

80. Steel thrust washer.

81. Assemble the 2nd (40T) and 1st (42T helical) gear pack with the synchromesh hub and steel bushes. Lower the assembly down into the box and slide the main shaft through the assembly.

82. Fit the pre-selected calibrated thrust washer with flat side towards first gear.

83. Refit the epicyclic reduction unit, see operation 9B.6.

84. Drive the front roller bearing onto the mainshaft and into the centre web of the gearbox.

85. Replace the circlip.

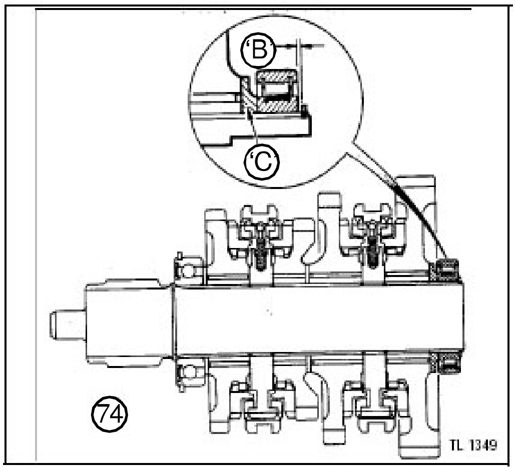

Fig 33

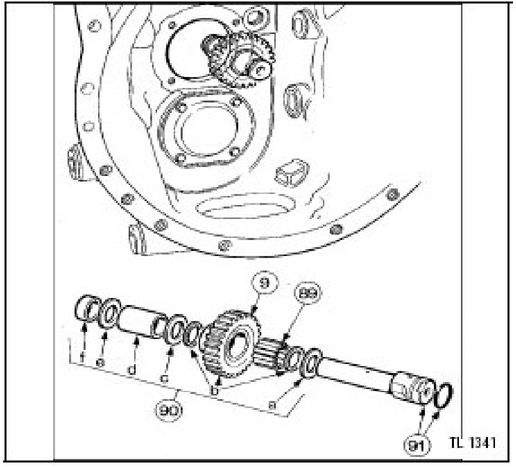

Fig 34

86. Locate the tagged thrust washer in the gearbox centre web with the convex side facing forwards.

87. Refit the needle roller bearing into the front of the mainshaft.

88. Locate the forward/reverse selector fork into the coupler of the layshaft synchromesh assembly.

89. Replace the rollers in the reverse idler pinion, a smear of petroleum jelly, NOT GREASE, will help retain them. There is a single row of 23 rollers with a spacer ring each side.

90. Refit the reverse idler to the gearbox, the order of assembly is as follows:

    a. Thrust washer b. Pinion

    c. Thrust washer d. Long spacer

    e. Thrust washer

91. Renew the 'O' ring on the idler shaft and enter from the bell housing end. Align the cut away portion on the front of the idler shaft to allow fitment of the input housing.

92. Hold the forward and reverse constant mesh gears in the gearbox and refit the transmission input shaft.
93. Refit reversible steel thrust washer to the front of the reverse ratio gear.
94. Refit the input housing assembly, see operation 9B.8 .
95. Refit the selector rails and forks, see operation 9B.5 .
96. Refit the clutch release mechanism, see operation 9A.6 .
97. Refit the gearbox to the tractor.
98. Renew the ‘O’ ring on the idler shaft and enter from the bell housing end. Align the cut away portion on the front of the idler shaft to allow fitment of the input housing.

9B.15 - SIDE SHIFT - SERVICE TOOL DETAILS

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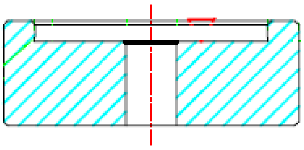
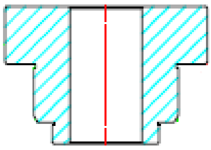
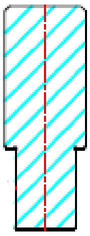
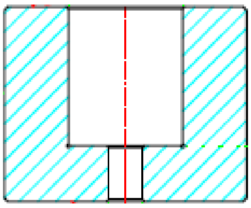
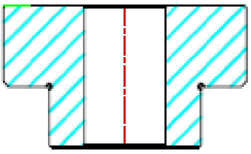
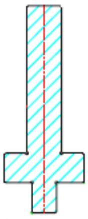
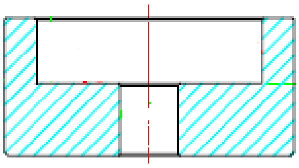
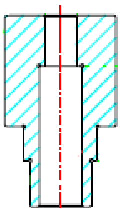
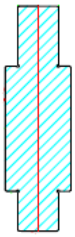
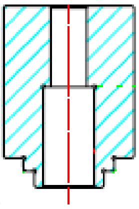
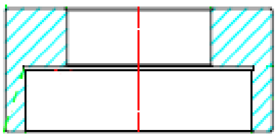
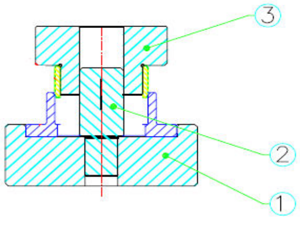
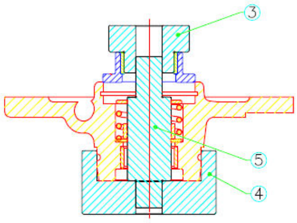
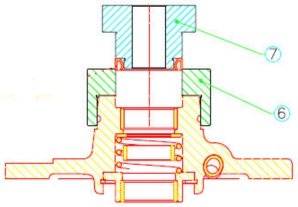
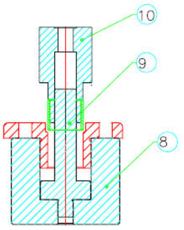
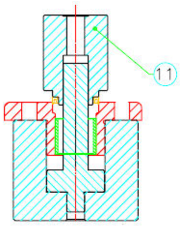
1		Locator	7		Pusher
2		Guide	8		Locator
3		Pusher	9		Guide
4		Locator	10		Pusher
5		Guide	11		Pusher
6		Locator			

9B.15 - SIDE SHIFT - SERVICE TOOL DETAILS

SERVICE TOOL NUMBER	DESCRIPTION	IMAGE	REMARKS
SER3000007	Pressing tool (Bush to collar)		1- Locator 2- Guide 3- Pusher
	Guiding tool (SS housing)		4- Guide 5- Locator
	Pressing tool (Seal into SS housing)		6- Locator 7- Pusher
	Pressing tool (Bush into Planetary hsg.)		8- Locator 9- Guide 10- Pusher
	Pusher		11- Pusher

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SECTION 9

PART C

TRANSFER GEARBOX AND DRIVE SHAFT

Transfer Gearbox and Drive Shaft- 4 Wheel Drive

Part C

Operation No.	Description		Page No.
9C.1	Specification	...	9C - 3
9C.2	General description - Transfer gear box	...	9C - 3
9C.3	Drive shaft - removal	...	9C - 5
9C.4	Drive shaft - overhaul	...	9C - 6
9C.5	Transfer gears - overhaul	...	9C - 9
9C.6	Transfer gearbox - removal	...	9C - 11
9C.7	Transfer gearbox - overhaul	...	9C - 13
9C.8	Drive shaft seal replacement - all models	...	9C - 16

9C.1 SPECIFICATION:

Model application	...	MF2605/2615 4 WD

Bolt Torques

Pinion bearing assembly	...	80 lbf.ft. (108 Nm)
Transfer box to casing	...	63 lbf.ft. (86 Nm)
Drive shaft flange bolts	...	48 lbf.ft. (65 Nm)
Drive coupling bolt	...	92 lbf.ft. (125 Nm)
Idler shaft end float	...	0.004 - 0.008 inch (0.10 - 0.20 mm).

Special Tools

MF.490	...	Four-wheel drive cassette seal installer.
SER / 060	...	Pinion lock nut ‘C’ spanner.
SER / 061	...	Pre load checking gauge aid

9C.2- General Description Transfer Gears

The drive for the front axle is taken from the pinion shaft by a gear splined to a hub located between the pinion bearings and the retaining nut. There are two sets of idler gears, the first set being a compound set running on needle roller bearings on a hardened sleeve around the PTO shaft. The second, is a single gear which is mounted with in the transfer box and drives the output gear to the drive shaft.

The output gear with in the transfer box is free to rotate on the front of the output shaft. The rear face of the gear is fitted with a simple tooth type coupling. Engaging with the gear and splined to the output shaft is a sliding coupler with a light spring between the gear and coupler to assist in disengagement. Behind the sliding coupler is an abutment ring, held in place on the shaft by a circlip.

Between the abutment ring and the coupler there are three radial toggle pins which pass through to the centre of the shaft and engage in a groove in the actuator shaft.The actuator shaft is controlled through linkage by the operator.

When the control rod is pulled up and the actuator shaft moved forward, as shown in the lower half of fig 1 illustration. The three toggle pins are forced up in to the vertical position moving the sliding coupler forward against the abutment ring into the engaged position.Moving the actuator shaft to the rear, as shown in the upper half of fig 1 illustration. This moves the toggle pins down into the shaft and allows the sliding coupler to disengage under pressure from the return spring. The teeth on the gear and the coupler are shaped to allow engagement and disengagement under load.

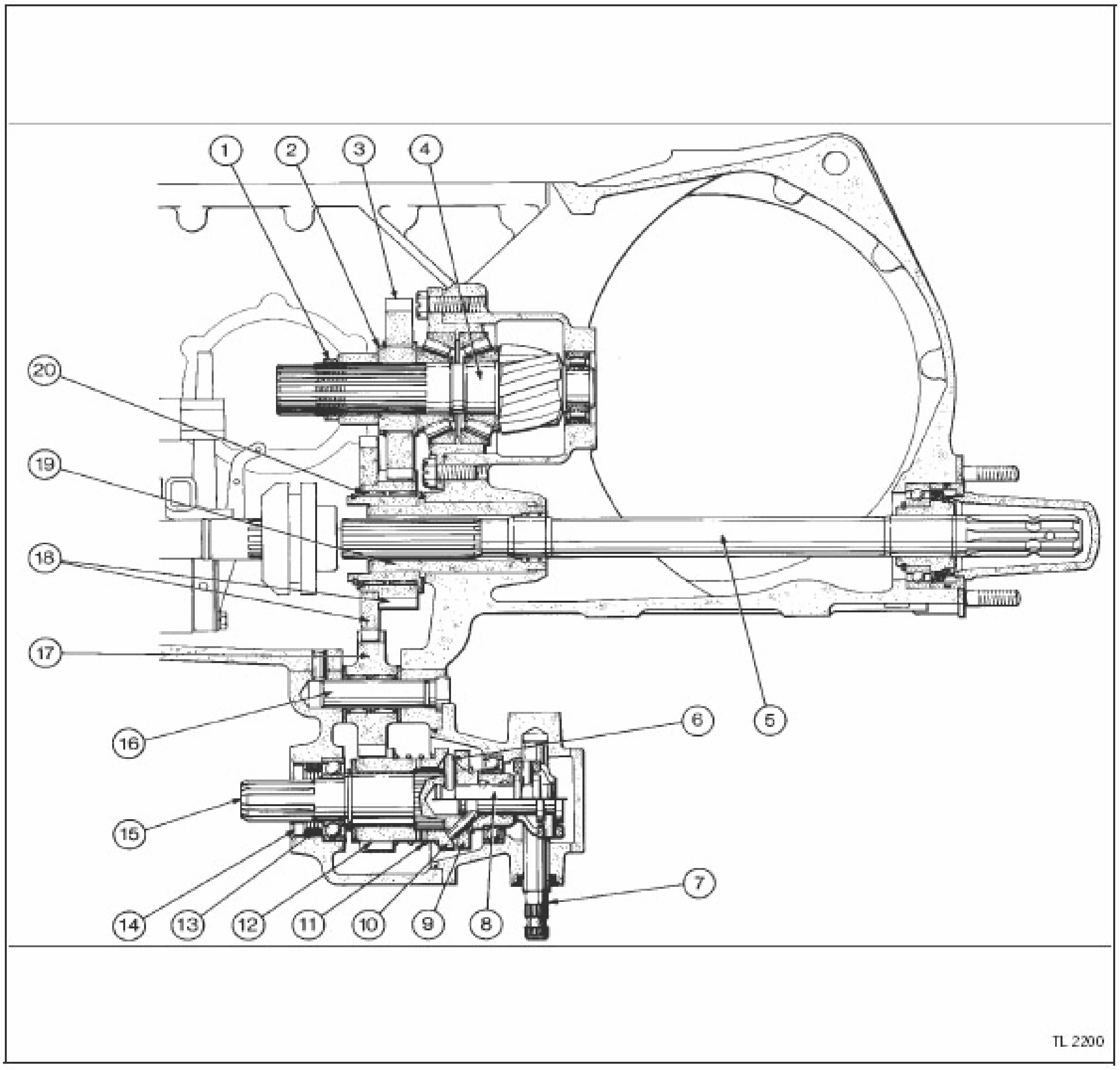

Fig 1

1. Retaining nut.
2. Drive gear hub.
3. Drive gear.
4. Pinion shaft.
5. PTO shaft.
6. Toggle pin.
7. Actuator shaft.
8. Actuator piston.
9. Abutment ring
10. Clutch coupler.
11. Retaining spring.
12. Drive gear.
13. Oil seal.
14. Dirt seal.
15. Drive shaft.
16. Intermediate shaft.
17. Intermediate gear.
18. Idler gears.
19. Support sleeve.
20. Needle roller bearing.

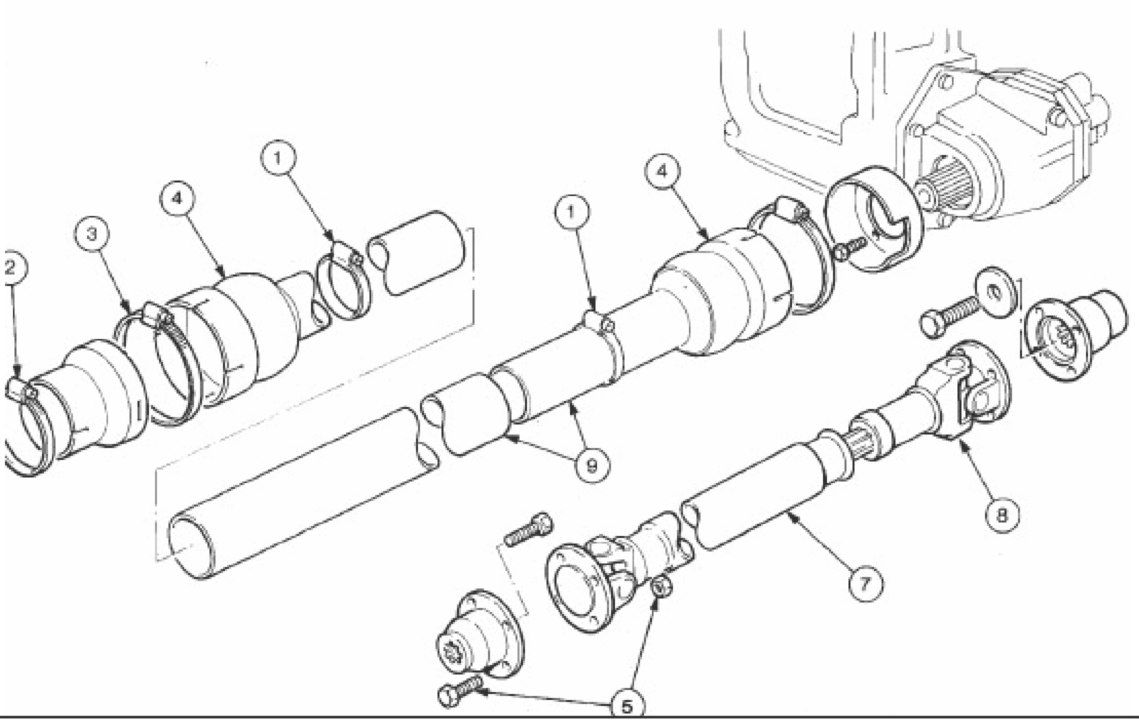

Fig 2

9C.3 - DRIVE SHAFT

Removal and refitment

Removal

1. Slacken the two clips on the guard.
2. Slacken the clip on the guard at the transfer box end.
3. Remove the clip from the guard at the axle end.
4. Slide the guard at both ends towards the centre to expose both couplings.
5. Remove the four bolts from each coupling and lift the drive shaft clear of the tractor.
6. Slide the rear part of the coupling back to expose the sliding joint in the shaft.
7. Unscrew the retaining ring.
8. Slide the rear part of the coupling off the shaft.
9. The guards can now be removed from the shaft.

Refitment:

10. Lubricate both universal joints and sliding joint with grease. To lubricate the sliding joint it will be necessary to remove the small plug and replace it with a grease nipple with a 1/4 in. UNF thread (Massey Ferguson part No. 13 811 X1).
11. When reassembling the drive shaft ensure that the two arrows stamped on the shaft are in line.
12. Apply Massey Ferguson Stud Lock (Loctite 270) to the threads of both sets of coupling bolts and tighten the nuts to a torque of 48 lbf.ft. (65 Nm).
13. The drain hole in the guard at the axle end must be at the bottom.
14. Position the guards as shown in the illustration. Ensure that the drive shaft couplings are not rubbing on the inside of the guard.

9C.4 - DRIVE SHAFT

Overhaul

Dis-assembly

1. Remove the drive shaft, see operation 9C.3.
2. Using a soft drift, tap the outside of the bearing assembly to loosen the snap ring. Tap the bearing only hard enough to break the assembly away from the snap ring.

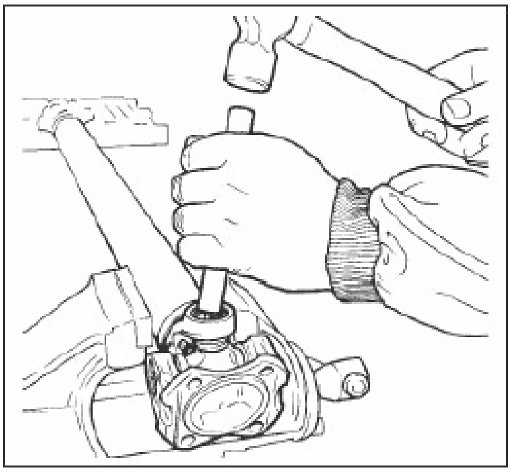

Fig 3

3. Remove the snap ring from the yoke. Turn the joint over and remove the opposite snap ring.
4. Set the yoke under a hand press with a piece of tube stock beneath it. Position the yoke with the grease nipple pointing up to prevent interference during dis- assembly.

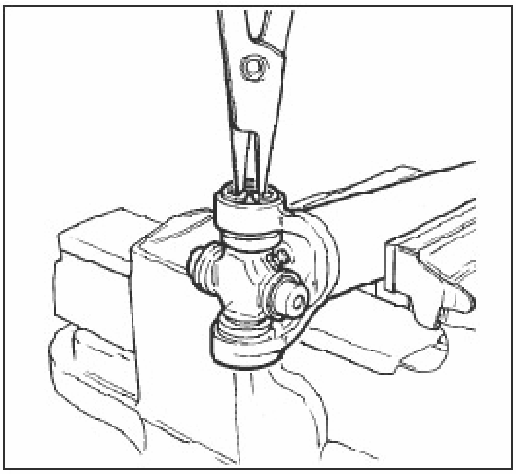

Fig 4

5. Place a solid plug on the upper bearing assembly and press it through to release the lower bearing.
6. If the bearing assembly will not pull out by hand after pressing, tap the base of the lug near the bearing assembly to dislodge it.

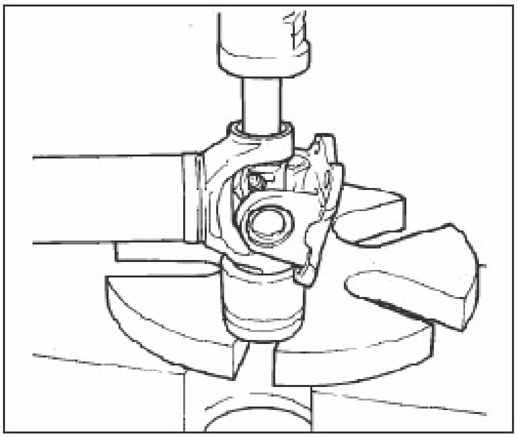

Fig 5

7. To remove the opposite bearing assembly, turn the yoke over and straighten the cross in the open hole. Then carefully press on the end of the cross so the remaining bearing assembly moves straight out of the bearing cross hole.
8. If the cross or bearing assembly are not in line, the bearing assembly will score the walls of the cross hole and ruin the yoke.
9. Repeat this procedure on the remaining bearing assemblies to remove the cross from the yoke.

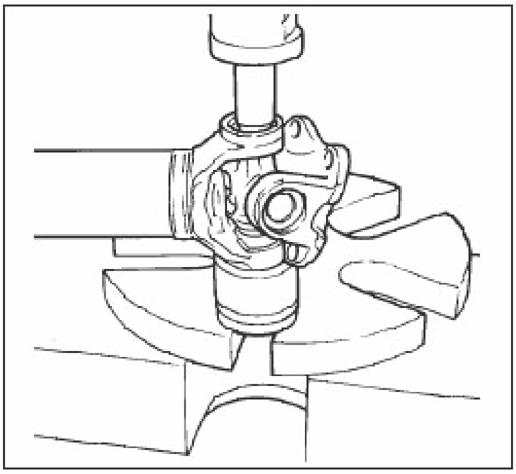

Fig 6

Re-assembly

10. Pack the four cavities of the cross with a high quality, extreme pressure N.L.G.I Grade 1 or 2 grease.
11. Pack each bearing assembly almost full with grease.
12. Position the cross in the yoke with its grease nipple on the inboard side (toward the driveshaft).

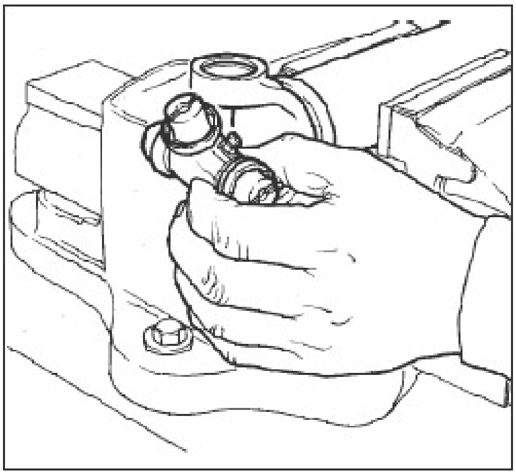

Fig 7

13. Move one end of the cross so that it projects through the bottom cross hole in the yoke.
14. Place a bearing assembly over the trunnion end of the cross and align it with the cross hole in the yoke.
15. Using a hand press, hold the trunnion in alignment with the cross hole and place a solid plug on the bearing assembly.

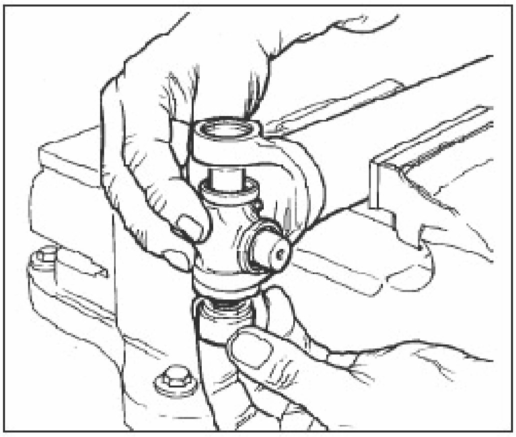

Fig 8

17. Fit a snap ring.
18. Repeat procedures 14 to 17 to assemble the opposite bearing.
19. If the joint is stiff, strike the yoke ears with a hammer to seat the needle roller bearings.

CAUTION: Be sure that the snap rings are properly seated in the grooves.

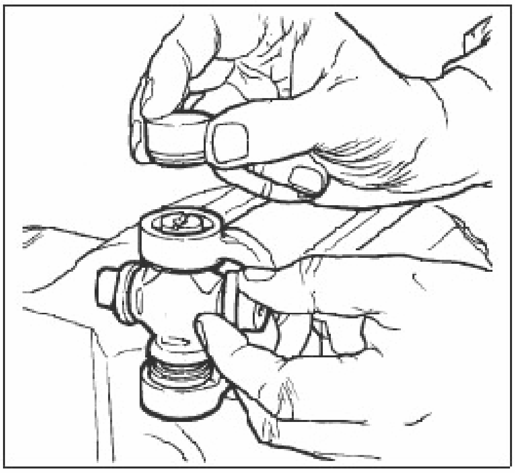

Fig 9

20. Repeat procedures 10 to 19 at the opposite end of the driveshaft if fitting a second kit.
21. Make sure you keep the grease nipples at each end of the driveshaft in line.

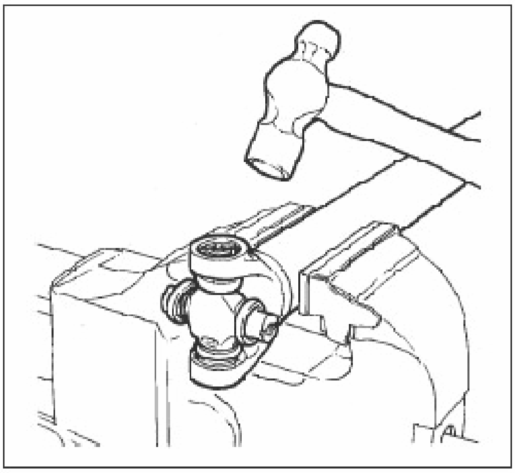

Fig 10

22. Ensure that both yokes at each end of the drive shaft are in phase. There are alignment arrows stamped on the slip yoke and on the tube shaft to assure proper phasing when assembled.
23. Fit the re-assembled driveshaft to the tractor.
24. Apply more grease through the grease nipples until grease appears at all four bearing seals.

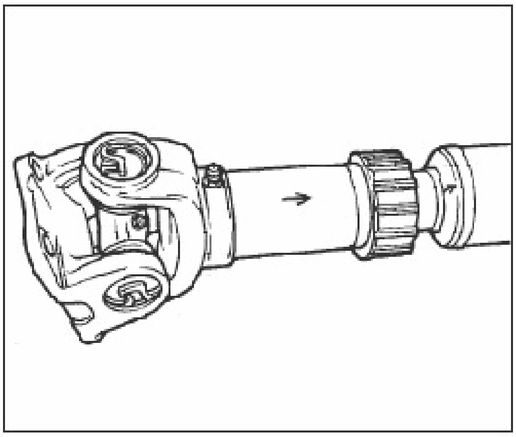

Fig 11

9C.5 - TRANSFER GEARS

Overhaul

Dis-assembly

1. Split the tractor between the gearbox and the centre housing and remove the hydraulic lift pump.
2. Remove the transfer gearbox, see operation 9C.6
3. Remove the PTO shaft, see operation 12A - 4.
4. Remove the snap ring and slide the pinion off the hub.
5. Remove the six bolts and spring washers.
6. Screw one of the bolts into each of the two tapped holes.
7. Tighten the bolts, thus withdrawing the pinion assembly.

NOTE : *Refer to Fig 14.*

8. Release the tab washer (Item 10 in Fig 14) from the lock nut by using a cold chisel or screw driver.
9. Using a lock 'C' spanner SER / 060 and preload checking gauge SER / 061 aid and remove the lock nut.
10. Remove the tab washer.

    NOTE: *Care should be taken to avoid damaging the threads of the pinion if it is to be reused.*

11. Refer paragraph number 9 to remove the second lock nut.
12. Remove the splined hub.
13. If necessary, remove the housing complete with bearings.
14. Remove the external circlip.
15. Remove the thrust washer.
16. Remove the intermediate gear, roller bearings and spacer.
17. Drive the needle roller bearing out of the end of the bearing support tube.
18. The inner bearing sleeve "A' is fixed to the bearing support tube "B' by Massey Ferguson Retainer Compound (Loctite 601). If there is a need to replace the sleeve due to bearing failure it can be removed by heating the sleeve up to a temperature of approximately 302°F(150°C) this will release the Retainer Compound so that the sleeve can be pulled off the support tube.

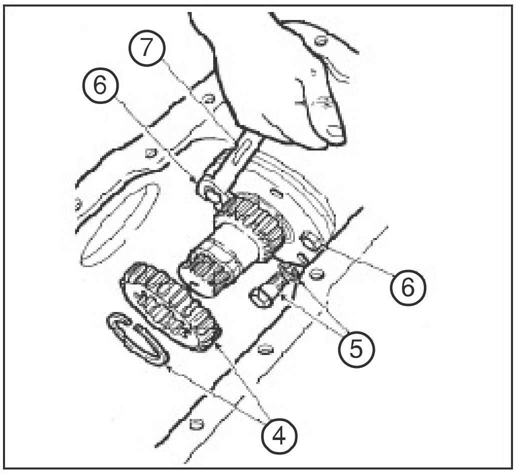

Fig 12

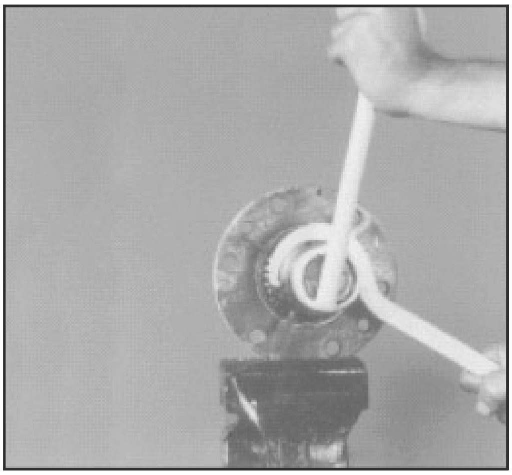

Fig 13

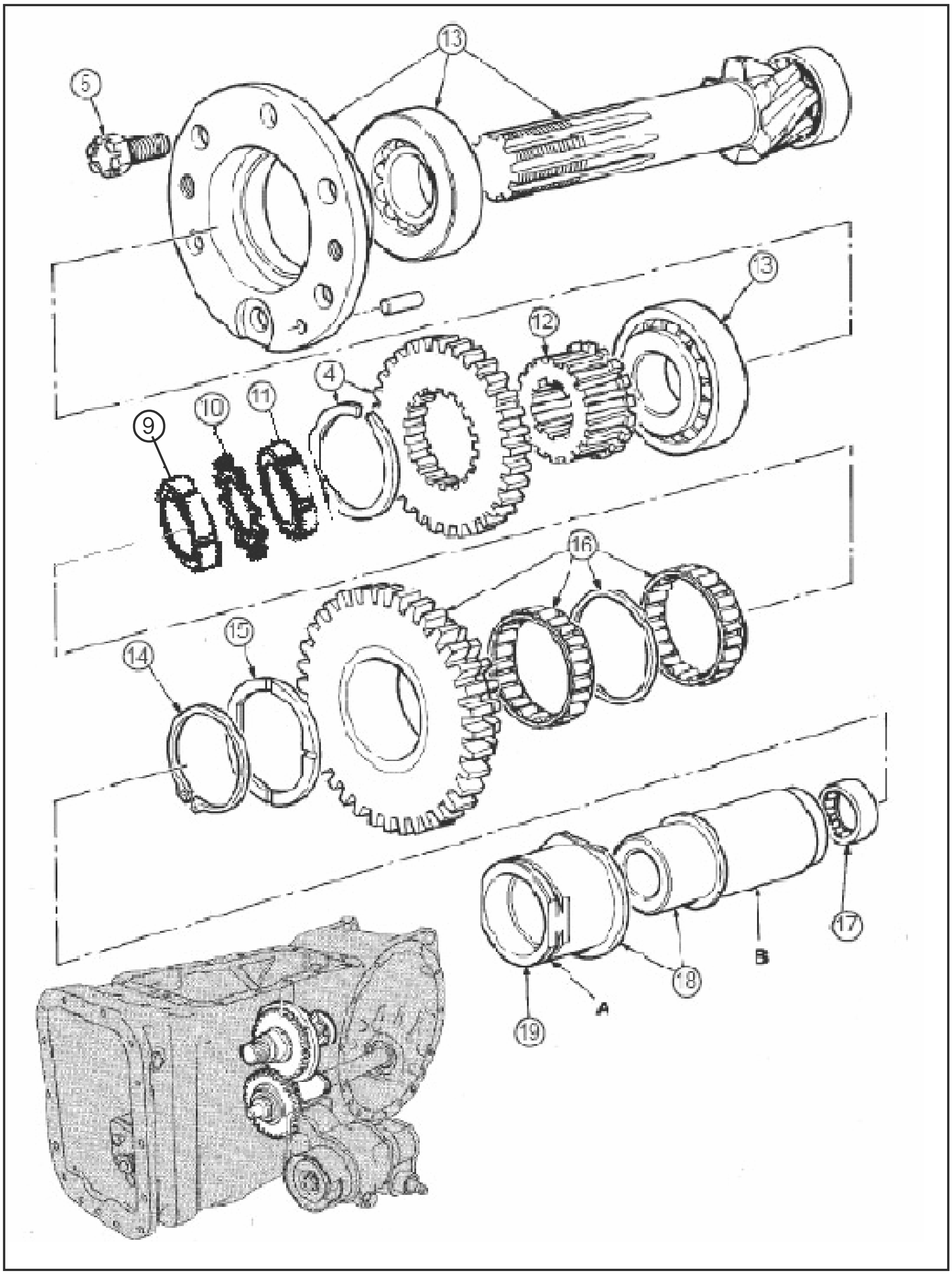
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Fig 14

The bearing support tube “B’ is also retained in the centre housing by the use of Massey Ferguson Retainer Compound (Loctite 601). Since there are no moving parts associated with this item it is unlikely that it will require removal.

Examination : Clean and carefully examine all the components, especially those subject to movement, and renew any items that show signs of damage or wear. Renew all circlips, snap rings and ‘O’ rings, when re-assembling ensure that they are correctly located in their grooves.

Re-assembly

The re-assembly of the unit is a reverse procedure of its dis-assembly. The following instructions are a further guide with details on any particular instructions that may apply.

19. If the inner bearing sleeve has been removed, clean the external surface of the bearing support tube with fine emery cloth. Degrease both components and dry. Apply Massey Ferguson RetainerCompound (Loctite 601) to both the surfaces and slide the inner bearing sleeve into position with the machined flat uppermost as shown in the illustration. Wipe off any excess compound. Allow 15 minutes for the Retainer Compound to cure before proceeding further with the assembly.
20. If the pinion bearing assembly has been taken apart to renew the splined sleeve or bearings, it will be necessary to reset the bearing pre-load.
21. When refitting the transfer box to the centre housing apply Massey Ferguson Instant Gasket (Loctite 515) to the mounting face of the box. Apply Massey Ferguson Stud Lock (Loctite 270) to the drive shaft flange bolts.
22. The following bolt torques will apply:

Pinion bearing assembly	80 lbf.ft.(108 Nm)
Transfer box to casing	63 lbf.ft.(86 Nm)
Drive shaft flange bolts	48 lbf.ft.(65 Nm)

9C . 6 TRANSFER GEARBOX

Removal and refitment

Removal

1. Drain the transmission oil into a clean container.
2. Loosen the clip on the small diameter part of the drive shaft guard. Remove the clip at the transfer box end and slide back the drive shaft cover.
3. Remove the drive shaft coupling nuts and bolts.
4. Disconnect the control rod at the lower end by removing the split pin and washer.
5. Remove the four bolts.
6. Remove the transfer box. It will be held to the centre housing by the two dowels, use a lever to carefully pry it away from the casing.

Refitment

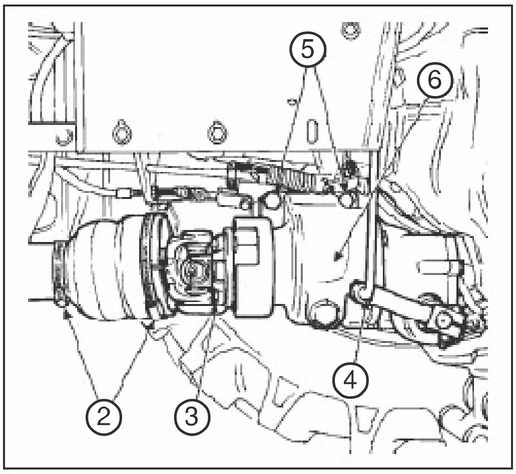

Fig 15

7. Clean the mating faces of the centre housing and the transfer box.
8. Reverse procedure 1 to 6 except:

   a. Coat the mounting face of the transfer box with Massey Ferguson Instant Gasket (Loctite 515)

   b.Tighten the mounting bolts to a torque of 63 lbf.ft (86 Nm).

   c. Tighten the drive shaft coupling nuts and bolts to a torque of 48 lbf.ft. (65 Nm).

   d.Fit a new split pin when connecting the control rod.

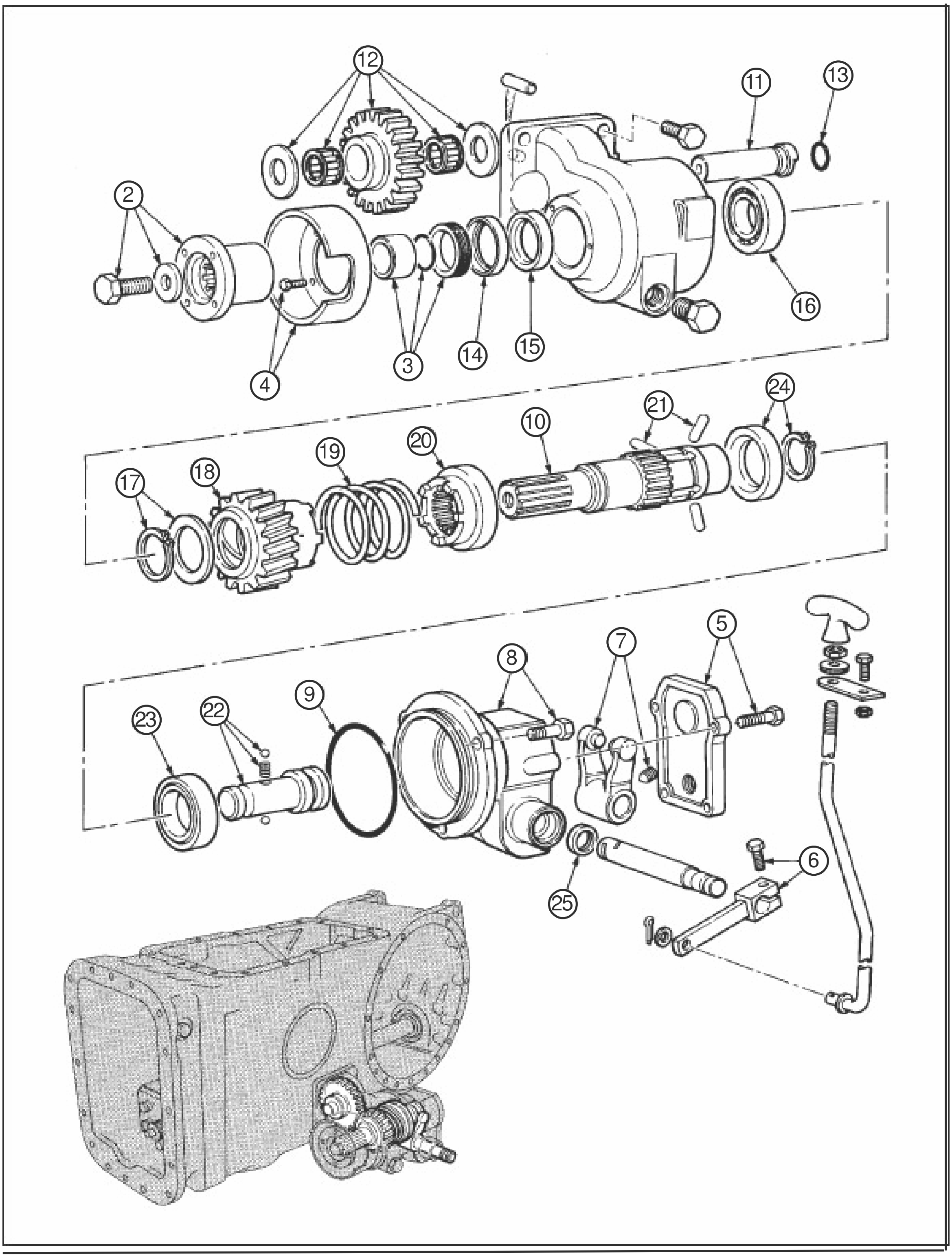
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Fig 16

9C . 7 TRANSFER BOX

Overhaul

Dis-assembly

1. Remove the transfer gearbox,
2. Remove the central coupling bolt, and washer, and then remove the coupling from the shaft.
3. Remove the sleeve, 'O' ring and seal.
4. Remove the three setscrews and the guard.
5. Remove the four back cover bolts and the cover.
6. Remove the securing bolt and operating lever.
7. Remove the locking screw and selector fork.
8. Remove the three bolts and the rear housing.
9. Remove and discard the 'O' ring.
10. Remove the shaft assembly complete with gear, bearings and selector mechanism by tapping the coupling end with a soft-blow hammer.
11. Screw a 0.472 inch (12 mm) bolt into the end of the idler shaft and pull it out of the housing.
12. Lift out the gear, two needle roller bearings and thrust washers.
13. Remove the 'O' ring from the shaft and discard.
14. Remove the seal sleeve from the housing.
15. Remove the oil seal from the housing.
16. Using a hydraulic press and bearing separator plate remove the front bearing from the shaft.
17. Remove the circlip and thrust washer.
18. Remove the output gear.
19. Remove the spring.
20. Slide the coupler off the shaft.
21. Remove the three toggle pins.
22. If necessary, very carefully pull the actuator shaft out of the main shaft. There are two spring loaded balls inside.
23. If necessary, remove the rear bearing from the shaft using a hydraulic press.
24. Remove the circlip and abutment ring.
25. Remove the operating shaft oil seal.

Examination

Clean and carefully examine all the components, especially those subject to movement, and renew any items that show signs of damage or wear.Renew all circlips, snap rings and 'O' rings. When re-assembling ensure that they are correctly located in their grooves.

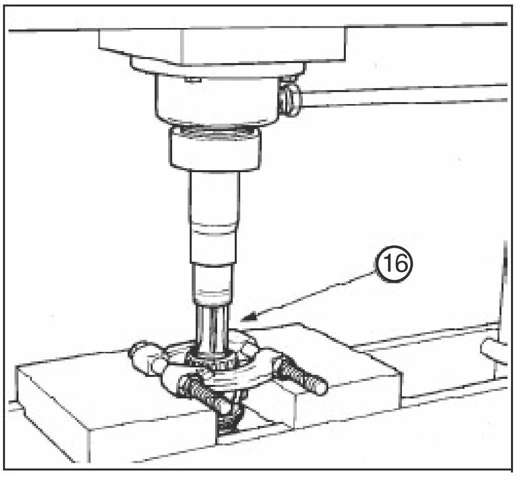

Fig 17

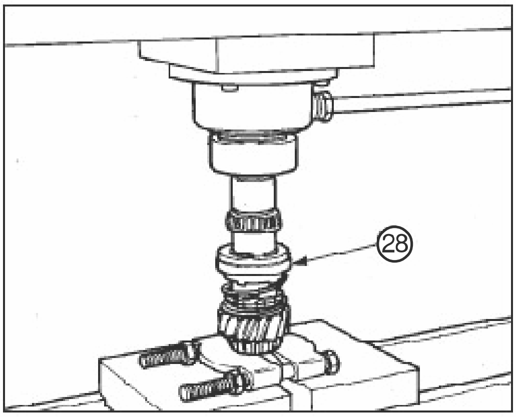

Fig 18

Re-assembly

26. Renew the operating shaft oil seal and lightly lubricate the lips of the seal.
27. Refit the abutment ring with the curved face facing forward to the main shaft with the circlip.
28. Refit the rear ball bearing.

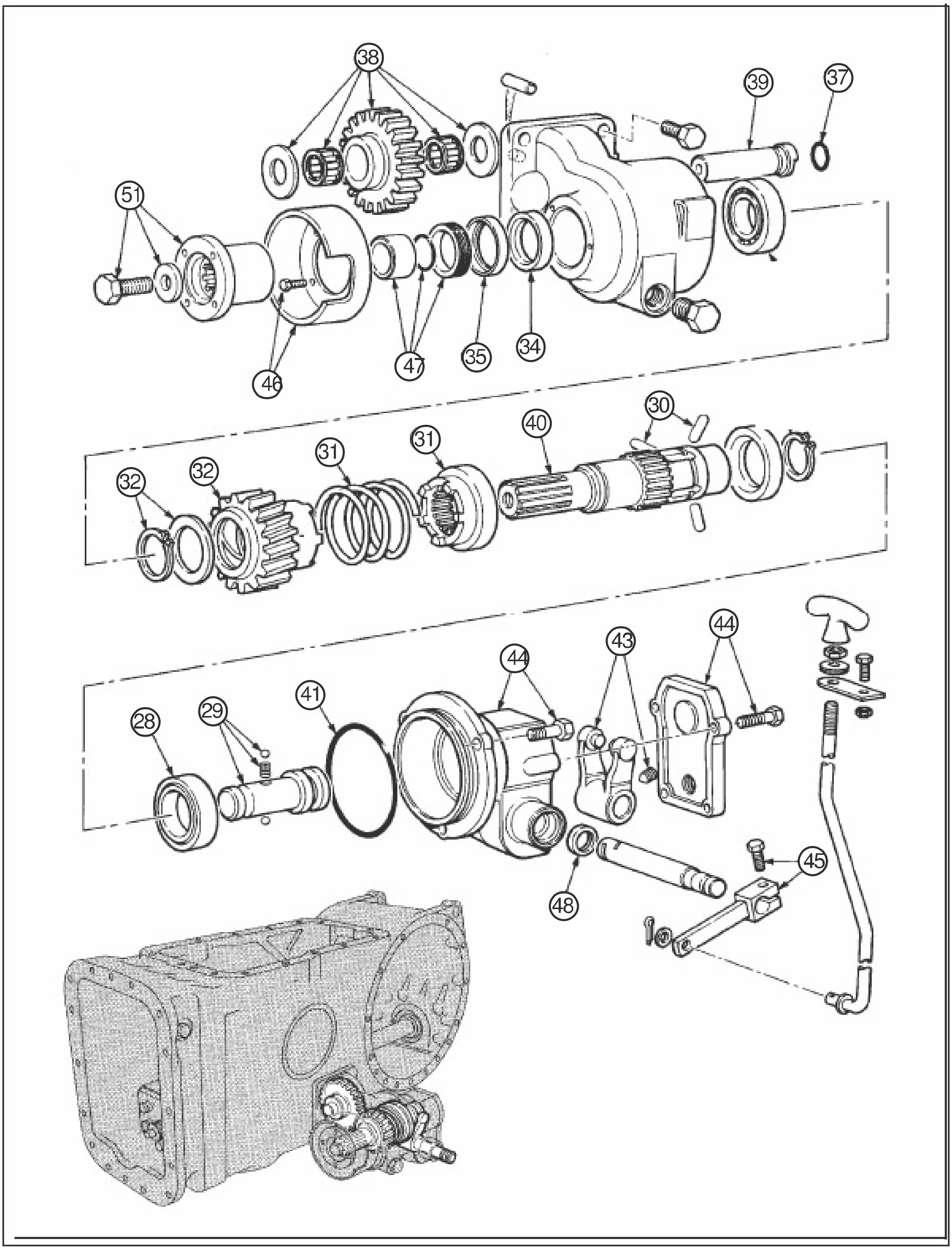
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Fig 19

29. Insert the two balls and spring in the cross drilling in the actuator shaft and fit it to the main shaft. Set the actuator in the first, disengaged, position.

30. Fit the three toggle pins through the slots in the main shaft so that they locate in the groove in the actuator shaft.

31. Refit the coupler and spring.

32. Slide the gear onto the shaft followed by the thrust washer and a new circlip.

33. Press the front ball race onto the shaft.

34. Coat the outside of the main shaft oil seal with Hylomar sealant and press it into the housing from the inside of the case so that the seal is 0.010 - 0.020 inch (0,25- 0,50 mm) below the face. The lip of the seal faces inwards.

35. Press the wear sleeve in from the front of the box until it is flush with the case. The rolled edge faces inwards.

36. Lubricate the lip of the seal with petroleum jelly.

37. Renew the ‘O’ ring on the idler shaft.

38. Fit the idler shaft thrust washer and then pass the roller shaft through the casing. Fit the two needle roller bearings into the gear and fit it to the shaft. Slide in the last thrust washer and press the shaft home.

39. Rotate the shaft so that the flat portion is opposite the aperture in the casing.

40. Fit the main shaft assembly.

41. Renew the ‘O’ ring and fit the rear housing to the case. Check that the housing fits over the end of the idler shaft correctly.

42. Check that the main shaft rotates without any binding.

43. Fit the operating shaft and fork. Apply Massey Ferguson Stud Lock (Loctite 242) to the thread of the locking screw and tighten.

44. Apply Massey Ferguson Instant Gasket (Loctite 515) to the face of the cover plate and fit it to the gearbox.

45. Refit the operating shaft and tighten the bolt. Check the operation for engagement and disengagement.

46. Refit the drive shaft guard.

47. Renew the ‘O’ ring on the main shaft.

48. Press a new dirt seal onto the seal spacer ensuring that it is fitted to the end without the recess for the shaft ‘O’ ring.

49. First coat the splines of the shaft with Hylomar sealing compound, and the dirt seal with a liberal amount of general purpose grease.

50. Refit the spacer and seal assembly.

51. Refit the drive coupling applying Massey Ferguson Stud Lock (Loctite 270) to the threads of the central bolt and tightening to a torque of 92 lbf.ft. (125 Nm).

52. Carry out a final check ensuring that the gears and shafts run freely.

53. Refit the transfer box to the tractor, see operation 9C.6.

9C.8 DRIVE SHAFT SEAL REPLACEMENT

Removal and refitment

Special Tools:

MF.490 -- 4WD Cassette seal installer

Removal

1. Drain the oil from the transmission.
2. Slacken the two clips on the guard.
3. Slacken the clip around the guard at the transfer gearbox end.
4. Slide the guard to the left to gain access to the coupling.
5. Remove the four bolts from the coupling and lower the shaft to the ground.
6. Remove the drive shaft and seal as described in operation 9C - 7 paragraphs 17 to 25 and 35 to 38 inclusive.
7. Replace the drive shaft as described in paragraphs 49 to 52 inclusive.
8. Renew the 'O' ring.

Installing the new seal

9. Liberally coat the inside of the seal with petroleum jelly.
10. Press the sleeve into the seal so that the front (flat) face of the seal is flush with the end of the sleeve.
11. Slide the seal over the output shaft as shown until the seal is just entering the housing.
12. Special tool MF.490 has been designed to install the seal to the correct depth in relation to the housing and sleeve. It also presses the seal in the correct location.
13. Screw the stud of special tool MF.490 into the end of the output shaft.
14. Slide the assembly tool over the stud and shaft.

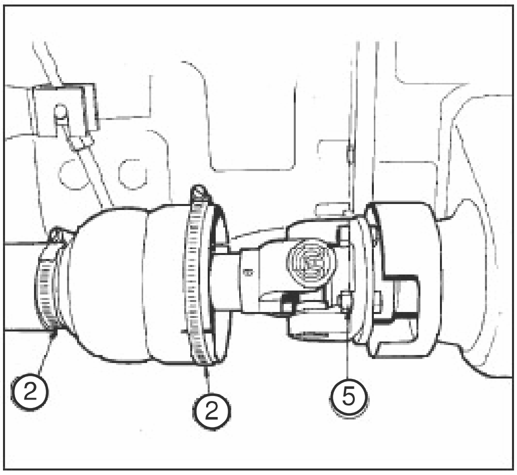

Fig 20

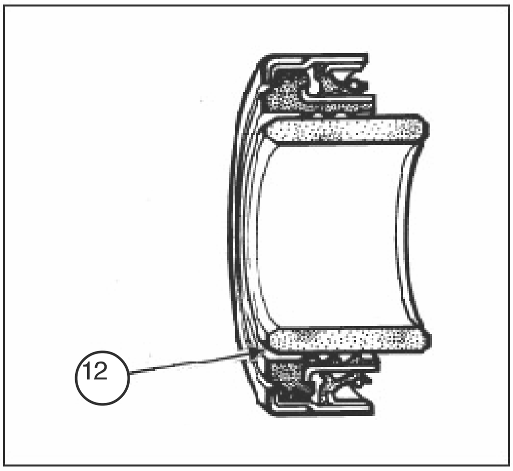

Fig 21

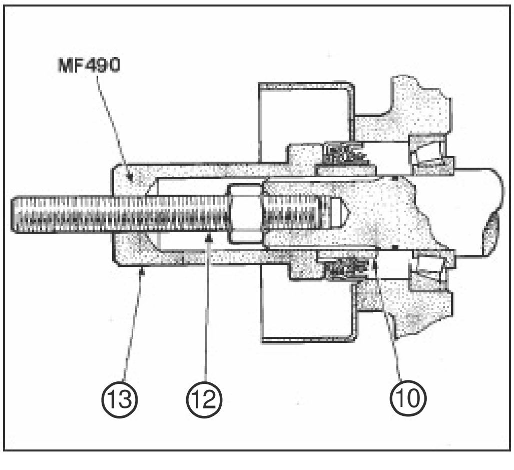

Fig 22

15. Fit the nut and washer.
16. Screw the nut upon the stud until the tool pushes seelve hard against the bearing. The seal is now in the correct position.
17. Remove the tool.

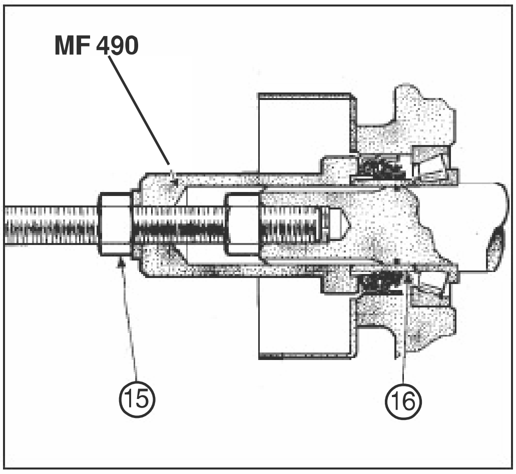

Fig 23

18. The correct position of the seal is 0.118 inch (3 mm) behind the front face of the sleeve (See illustration in Fig 24).
19. Coat the splines of the output shaft with Hylomar sealant.
20. Refit the drive coupling, drive shaft and guard as described in operation 9C - 3.
21. Apply Massey Ferguson studlock (Loctite 270) to the central bolt and tighten to a torque of 92 lbf.ft (125 Nm).
22. Apply Massey Ferguson studlock (Loctite 270) to the coupling bolts and tighten to a torque of 48 lbf.ft. (65 Nm).

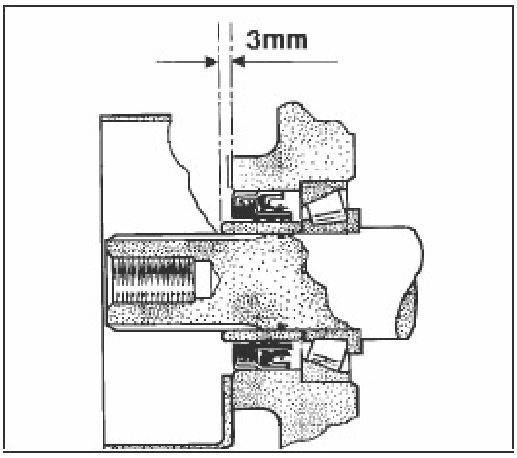

Fig 24

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SECTION 10

Rear Axle

INDEX

10 A REAR AXLE DIRECT DRIVE

10A.1 CROWN WHEEL PINION

PART A

Rear Axle-Direct Drive
Table of Contents

Operation No.	Description			Page No.
10A. 1	Specification	...	...	10A - 3
10A. 2	General Description	...	...	10A - 4
10A. 3	Axle Shaft-Drum Brake	...	...	10A - 5
10A. 4	Axle Shaft Overhaul	...	...	10A - 5
10A. 5	Axle Housing Removal	...	...	10A - 7
10A. 6	Lower Link Pin Removal	...	...	10A - 9

10A.1 SPECIFICATION

Rear Axle and Final Drive

Type : Direct Drive with 6X37 Crown Wheel pinion.

Track Width : 52 to 72 inch (1320 to 1828 mm) (Adjustable in steps of 4 inch (102 mm))

Brakes Type : Dry Type Mechanical, Drum Brakes .Cam Operated 14X2 inch (355.6 X 50.8 mm) Size 2 Nos on LH and RH Sides with non Asbestos Liner

Location : Wheel end mounted

Method of operation : Manual, Individual LH/RH or combined pendant type Pedals

Parking Brakes

Type and Location : Service Brakes acts as Parking Brake Mounted on left hand side of the fender

Method of Operation : By hand lever through brake cables

Special Tools

Dial Test Indicator Gauge

SER / 019 : Rear Axle shaft bearing remover

SER / 022 : Rear Axle shaft bearing replacer

SER / 093 : Axle shaft collar remover

SER / 028 / 20 : Differential bearing puller

SER / 059 / 056 : Pinion crown wheel bearing pusher

Bolt Torques

Rear Wheel Nuts : 200 lbf ft. (271 Nm).

Axle Housing to Centre Housing : 80 - 90 lbf ft. (108 - 122 Nm)

Axle Housing to Axle Retainer Hub : 45 - 50 lbf ft. (61 - 68 Nm)

Lower Link Shaft : 50 – 55 lbf ft. (68 - 75 Nm)

Axle shaft End Float : 0.002 to 0.008 inch (0.05 to 0.2 mm).

Stabillzer bracket fender bolts : 55 - 75 lbf.ft.(75 - 102 Nm)

Lower link pin nut : 120 lbf.ft. (163 Nm)

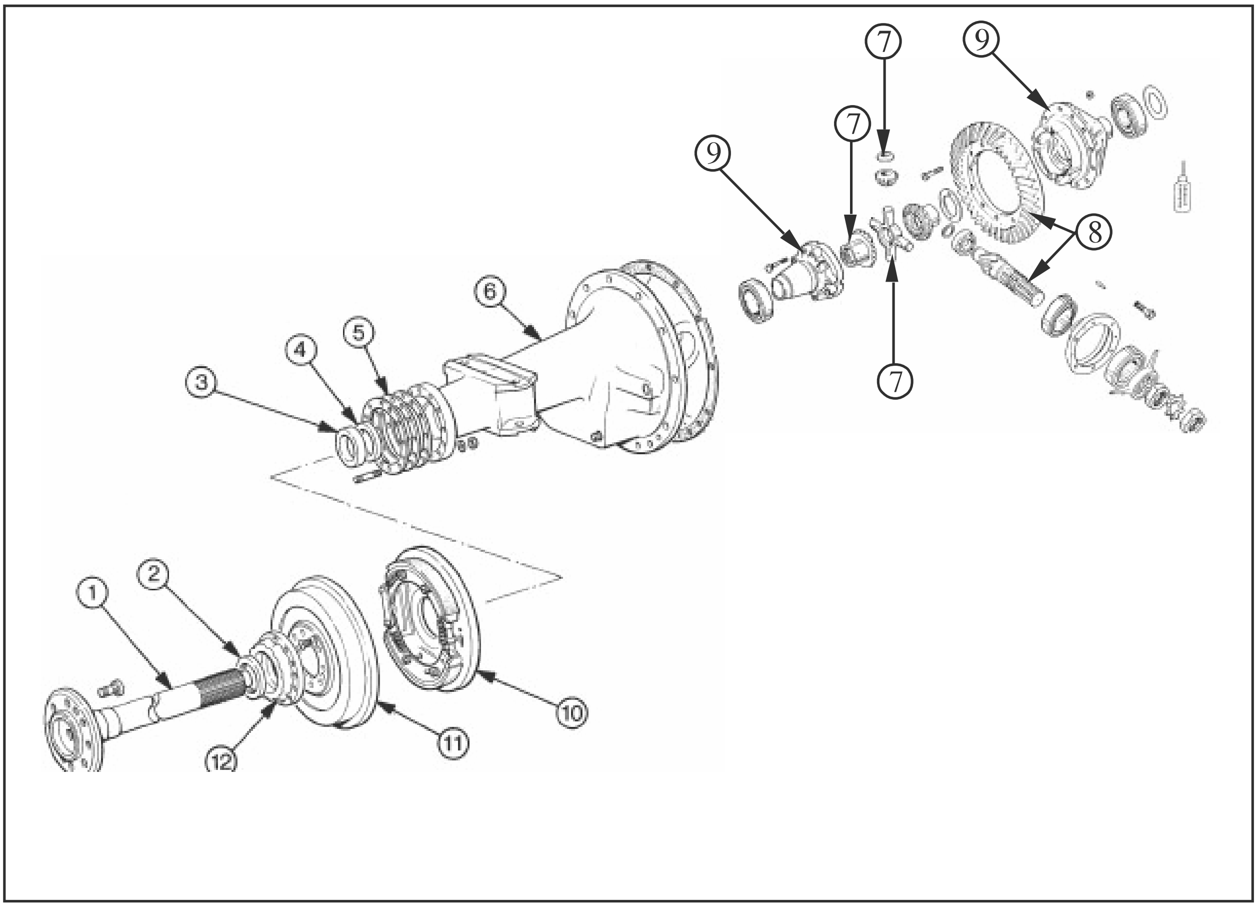

Fig. 1

1.	Axle shaft
2.	Oil Seal
3.	Retainer
4.	Oil Seal
5.	Axle Shims
6.	Axle Housing
7.	Differential Gears and Pinions
8.	Crown wheel and Pinion
9.	Diff case LH and RH
10.	Brake assembly
11.	Brake drum
12.	Retainer housing

10A. 2 GENERAL DESCRIPTION

The direct drive rear axle construction is shown in Fig.1. The axle shafts are splined directly into the differential gears and fitted with drum type brakes.

10A.3 AXLE SHAFT - DRUM BRAKE

Removal and Refitment

Special tools / Gauge

Dial Indicator gauge

Removal

1. Jack up the tractor under the axle housing to be serviced
2. Drain the transmission oil from centre housing and transmission case
3. Remove the rear wheel.
4. Slacken the brake adjuster. (Item 4 in Fig 2).
5. Remove the brake drum. (Item 1 in Fig 2).
6. Release the brake rods from the Cam shaft
7. Remove 12 bolts securing the retainer hub to Axle Housing. (Item 6 in Fig 2).
8. Withdraw the axle shaft complete with shims hub and bearing assembly and brake assembly. (Item 2 in Fig 2).
9. Remove the brake assembly and shims from the shaft. (Item 3 in Fig 2).

Refitment:

For refitment follow the reverse procedure of removal and ensure

1. Smear the inside of the brake camshaft bush in the axle housing with recommended grease.
2. Check the bearing cavity is full of recommended grease
3. Place the brake assembly and more shims than will be necessary on the axle shaft.
4. Taking care not to damage the oil seal on small end of axle housing. Place the axle shaft into the axle housing, simultaneously locating the brake camshaft.
5. Secure the hub with three of the bolts and spring washers, equally spaced and tighten to a torque of 45 - 50 lbs ft. (61 – 68 Nm).
6. Check the axle shaft end float on the left hand axle housing, using a dial test indicator gauge. (Item 1 in Fig 3). Remove shims as necessary to give an end float of 0.002 to 0.008 inch (0.050 - 0.2 mm) between the Axle ends.
7. Refit the remaining bolts and spring washers and tighten to torque of 45 - 50 lbf ft. (61 – 68 Nm).
8. Adjust the brakes

NOTE: *The right-hand axle shaft must be in place to enable this setting to be accomplished. If both shafts have been removed assemble the right-hand shaft with two shims to the value of 0.020 inch (0.51 mm), then make your adjustments on the other side. Start with one 0.015 inch (0.38 mm), two 0.020 inch (0.51 mm) and two 0.005 inch (0.13) mm shims.*

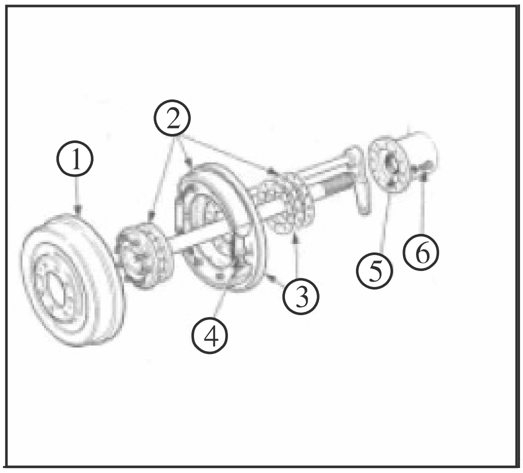

Fig. 2

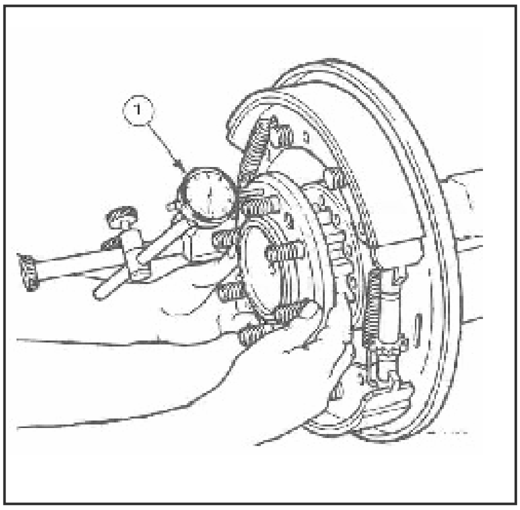

Fig. 3

S.NO	Shim thickness		Part number
	mm	inch	
1	0.0762 - 0.127	0.003 – 0.005	0183 259 M01
2	0.381 - 0.4318	0.015 – 0.017	0183 260 M01
3	0.508 - 0.5588	0.020 – 0.022	0183 261 M01

10A.4 AXLE SHAFT-DIRECT DRIVE-DRUM BRAKE

Over haul.

Disassembly

1. Remove the Axle shaft

WARNING: You are advised to wear eye protection during Procedure 2.

2. Drill the side of the bearing retaining collar using SER/093, then using a cold chisel, fracture the collar. (Item 1 in Fig 4).

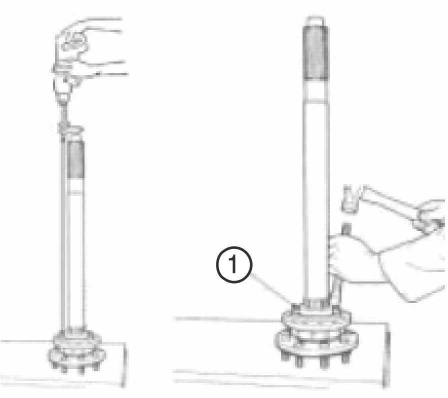

Fig. 4

3. With a hydraulic press, press the seal and bearing assembly . (Item 1 in Fig 5) off the shaft. Only remove the bearing cup if necessary.

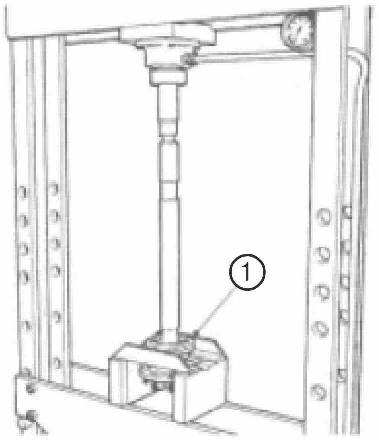

Fig. 5

4. Remove and discard the hub oil seal. (Item 1 in Fig 6).
5. Remove and discard the oil seal in the axle housing.

Re-assembly.

6. Coat the oil seal with loctite and press into the retainer hub up to the shoulder oil seal lip should face bearing. Fit a new cup if necessary (Item 2 in Fig 6).
7. Place the small quantity of high temperature grease between the oil seal and bearing. Position the bearing assembly, seal with retainer Hub and Axle shaft under a hydraulic press. Press the taper roller bearing cone in to position. (Item 1 in Fig 7).

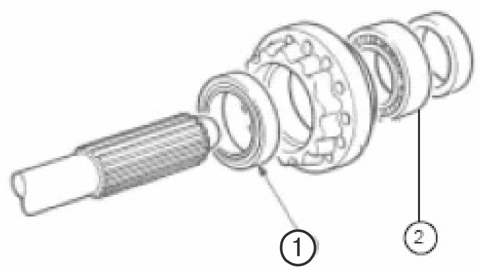

Fig. 6

8. Heat a new bearing retaining collar, until dull red and place it in position on the axle shaft.
9. Quickly drive the bearing retaining collar into position with a steel tube so that the hub and bearing assembly is held tightly in position. Ensure there is no gap between the collar and bearing cone (Item 1 in Fig 8) check with feeler gauge.
10. When cool, fill the bearing cavity with approximately 85 gm (0.187 lb) of high temperature bearing grease.
11. Replace the oil seal in the axle housing coating it first with loctite, the lip of the seal faces towards the crown wheel side.
12. Refit the axle shaft assembly.

10A. 5 AXLE HOUSING ASSEMBLY.

Removal and Refitment

1. Drain the transmission oil from transmission case and Centre Housing.
2. Remove the nuts and washers securing the Lower link to the axle housing.
3. Jack up the tractor under the axle housing being serviced. (Item 1 in Fig. 9).
4. Remove the rear wheel.
5. Support the tractor on a suitable stand or splitting trolley under the centre housing.

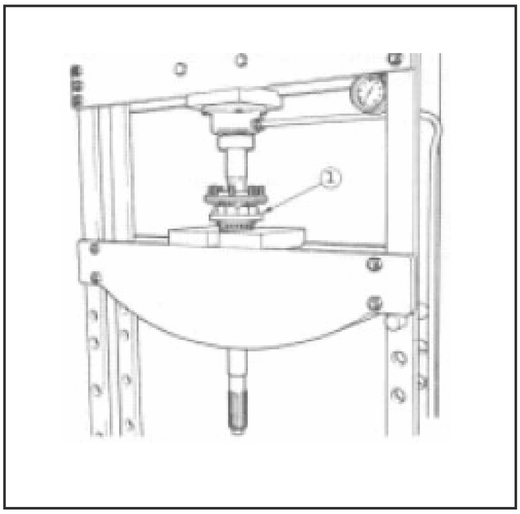

Fig. 7

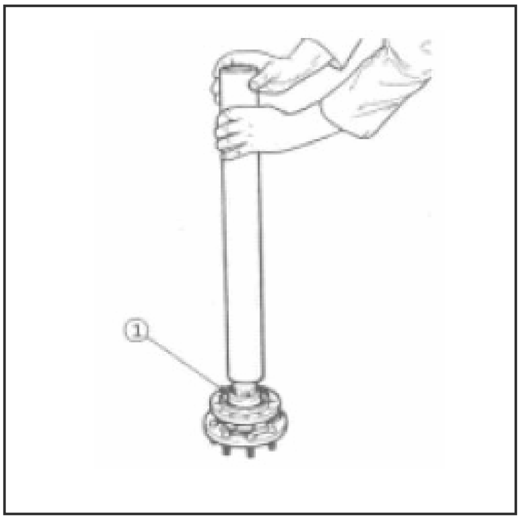

Fig. 8

6. Release the brake rods from the brake cam shafts.
7. Release the check chain at the check chain anchor bracket.
8. Remove the two nuts securing the stabiliser bracket to the axle housing.
9. Remove the stabiliser bracket.
10. Release the lift rod at the lift arm knuckle. (Item 2 in Fig. 9).
11. Remove the lower link assembly complete. (Item 3 in Fig. 9).
12. Disconnect the fender harness
13. Remove bolts from the fender. (Item 4 in Fig. 9).
14. Remove the fender Assembly.

WARNING: The axle housing is heavy and awkward to handle. Take care when removing and refitting.

15. Place a trolley jack under the centre of the axle housing being serviced, just supporting the housing.
16. Remove all nuts and bolts securing the axle housing to the centre housing. (Item 1 in Fig. 10).
17. Lower the axle housing slightly on the trolley jack.
18. Withdraw the axle housing assembly supported on the trolley jack.

CAUTION: When removing the left hand axle housing, the differential will need support to prevent it from falling out.

19. Remove the gasket from the centre housing and discard. (Item 2 in Fig.10).
20. Remove the thrust block from the left hand housing, if necessary. (Item 1 in Fig.11).
21. Remove the oil seal. (Item 3 in Fig. 10).

Refitment:

1. Replace the oil seal in the axle housing coating the outer diameter of oil seal with loctite. The lip of the seal should face towards crown wheel side.
2. If the shaft lower link has been removed from the axle housing, when refitting tighten the nut to a torque of (50 – 55 lbf ft.) 68 – 75 Nm. (Item 4 in Fig. 10).

For refitment follow the reverse procedure of removal and ensure

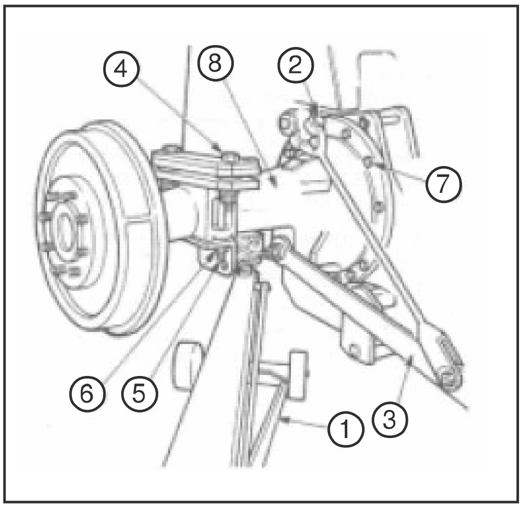

Fig. 9

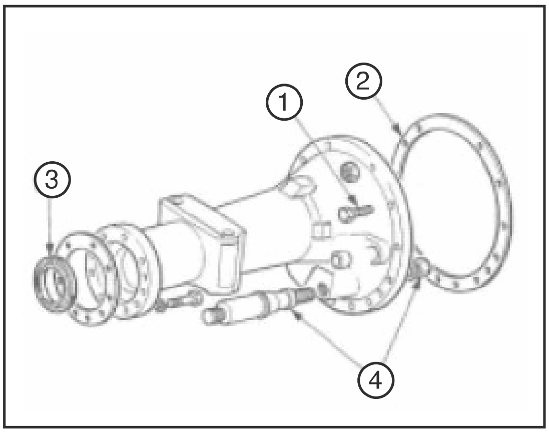

Fig. 10

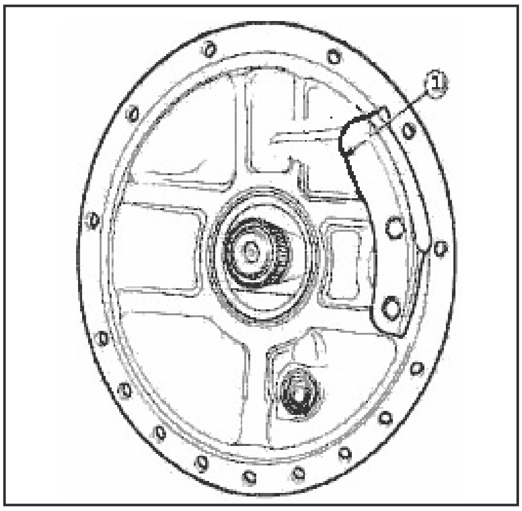

Fig. 11

(a) Fit a new gasket to the centre housing using petroleum jelly.

(b) When refitting the axle housing, take care to align the axle shaft splines in the differential unit and the studs through their holes in the axle housing.

(c) Tighten the axle housing nuts and bolts to a torque of 80 - 90 lbf ft. (102 – 122 Nm)

(d) Apply a few drop of loctite then fit and tighten the stabiliser bracket/fender bolts to a torque of 55 - 75 lbf ft. (75 – 102 Nm)

(e) Tighten the wheel nuts progressively and evenly to a torque of 200 lbf. ft. (271 Nm)

(f) Refill the transmission to the correct level with an approved oil.

10A. 6 LOWER LINK PIN - DRUM BRAKES

Removal and Refitment

Removal

Drain the transmission Oil.

1. Remove the axle housing.
2. Remove the nut and washer (Item 2 in Fig.12).
3. Remove the pin. (Item 1 in Fig. 12).

Refitment

1. Place a new pin in the axle housing if necessary.
2. Refit the washer and nut. (Item 2 in Fig.12).
3. Tighten the nut to a torque of 120 lbf. ft. (163 Nm).
4. Refit the axle housing.
5. Complete the rest of the assembly.
6. Fill up transmission oil to level mark.
7. Test for balanced brakes.

WARNING : The Axle housing is heavy and awkward to handle. Take care when both removing and refitting it.

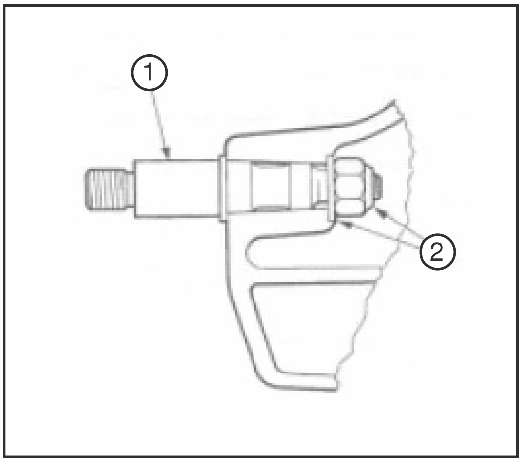

Fig. 12

PART B

Crown Wheel Pinion

Table of Contents

Operation No.	Description	Page No.
10A.1. 1	Specification … …	10A - 11
10A.1. 2	General Description … …	10A - 11
10A.1. 3	Differential Unit Overhaul … …	10A - 12
10A.1. 4	Crown Wheel and Pinion Overhaul … …	10A - 13
10A.1. 5	Differential Pre-load Check … …	10A -18

10A.1.1 SPECIFICATION

Type	:	Direct Drive with 6X37 Crown Wheel pinion
Crown wheel pinion ratio	:	6.1667:1

Special Tools

SER / 112	:	Differential Bearing pre load gauge (used in conjunction with SER / 060 and SER / 064)
SER / 018	:	Bench plate
SER / 017	:	Differential case holder adaptor (to be used with SER/018)
SER / 038	:	Hand press
SER / 059	:	differential case bearing removing adaptor used in conjunction with hand press SER / 038
SER / 020	:	Adaptor
SER / 025	:	Differential bearing cup replacer
SER / 030	:	Differential bearing cup remover
SER / 031	:	Adaptor (to be used with SER / 030)
SER / 060	:	Pinion lock nut “C” spanner
SER / 064	:	Perload checking gauge aid.
T 4062 A	:	Pre load weight

Bolt Torques

Differential case Bolts	:	76 – 85 lbf.ft. (108 Nm)
Crown Wheel Bolts	:	118 lbf.ft. (160 Nm)
Axle Housing Bolts	:	85 – 89 lbf.ft. (115 - 120 Nm)
Pinion Housing to Centre Housing Bolts	:	75 – 80 lbf.ft. (102 - 108 Nm)
Shaft Lower Link.	:	50 – 55 lbf.ft. (68 - 75 Nm)
Pinion Bearing pre load	:	18 – 22 lbf.inch. (2 - 2.5 Nm)

10A.1.2 GENERAL DESCRIPTION

The drive from the transmission main shaft is transmitted through the rear drive shaft and shear coupler / tube to a spiral bevel gear pinion driving the crown wheel and then through the axle shafts.

The driving pinion is supported in the centre housing by a straight roller pilot bearing and a pre loaded housing assembly carrying two tapered roller bearings.

The crown wheel is rivetted / bolted to the split differential case which is supported on each side by tapered roller bearings. The differential unit consists of two differential gears and four pinions.

The differential gears engages with axle shaft spline. The differential pinions run on differential cross and the thrust is taken by thrust washers behind the pinions and gears.

The pinion pre-load is set by tightening a nut behind the two taper roller bearings. The differential bearing pre-load is set with the aid of a special tool and variable thickness bearing shim which are fitted behind the bearing cup of the right hand axle housing.

10A.1. 3 DIFFERENTIAL UNIT

Overhaul :

Special Tools :

SER / 017 : Differential case holder adaptor (to be used with MF 10).

SER / 018 : Bench plate

SER/112 : Bearing pre-load gauge

SER / 020 : Adjustable puller main tool

Dis-assembly

WARNING : The axle housing and differential unit are heavy and awkward to handle. Take care when removing and refitting them.

1. Remove the left-hand axle housing.
2. Maneuver the differential assembly out of the centre housing.
3. Place the differential on a stand or in a vice (SER / 017 / 018). (Fig. 1)
4. Using puller SER / 020 / 028 remove the bearing right hand cone. (Fig. 2)
5. Remove the eight bolts. (Item 4 in Fig. 3)
6. Remove the differential case right-hand (Item 2 in Fig. 3)
7. Remove the 4 pinions and gears from differential cross complete with the thrust washers. (Item 3 in Fig. 3)
9. Remove the differential gears and their thrust washers. (Item 1 in Fig. 3)

Examination :

Examine all of the differential components and replace any that are worn out or damaged.

***NOTE** : If any of the differential gears or pinions are worn, a full set of four new differential gears and pinions must be fitted.*

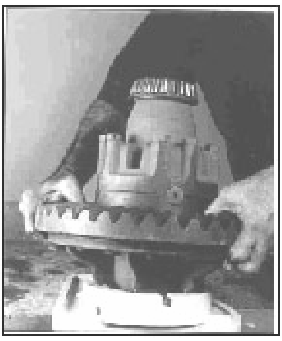

Fig. 1

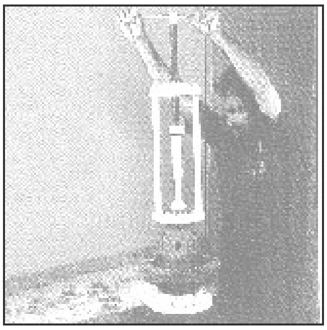

Fig. 2

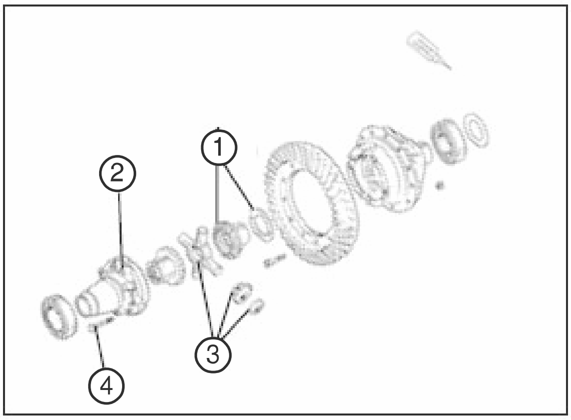

Fig. 3

Fig. 4

Reassembly

1. For reassembly follow the reverse procedures of the disassembly and ensure
   - (a) Refit the right hand differential case with left-hand aligning the number punches on left-hand and right-hand.
   - (b) Tighten the eight bolts to a torque of 76-85 lbf. ft. (108 Nm)
   - (c) Refit the bearing cone using (SER / 025)
   - (d) Refit the differential unit with care. It must engage with the splines on the right side axle shaft.

   ***NOTE** : If the differential bearings or case have been replaced, the pre-load must be checked. (Ref. Operation No. 10A.1.5)*
2. Refit the left hand axle housing,

10A.1. 4 CROWN WHEEL & PINION

Overhaul

Special Tools :

SER/112 : Bearing pre-load gauge

Disassembly

Crown Wheel

***NOTE** : The replacement crown wheel and pinion kit comprises of one pinion, one crown wheel, 12 nuts and bolts and one epoxy resin kit.*

1. Split the tractor between the centre housing and the gear box
2. Remove the Hyd. lift cover
3. Remove the axle Housing left-hand
4. Remove the differential unit
5. Place the differential unit on a bench.
6. Centre punch each of the rivets centrally.
7. Using a 13 -14 mm drill, drill out each of the rivet heads until they become detached from their shanks. (Item 1 in Fig. 5). (Ensure that the holes in diff. case left-hand are not getting elongated during the process of drilling out the rivets).
8. Drive out the rivets.
9. Separate the crown wheel from diff. case left-hand.

***NOTE** : crown wheels and pinions are supplied as matched sets, therefore when fitting a new crown wheel, the pinion must also be replaced.*

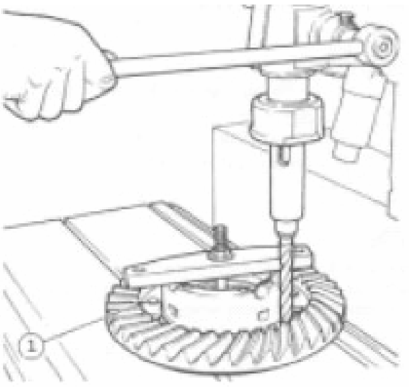

Fig. 5

Pinion:

1. Remove the six mounting bolts. (Item 1 in Fig. 6).
2. Screw one of the bolts into each of the two tapped holes. (Item 2 in Fig. 6).
3. Tighten the bolts as shown using a ring spanner thus withdrawing the pinion assembly.
4. Remove the locking nut as follows.

WARNING : Eye protection goggle must be worn during the following operations

NOTE : *Great care should be taken to avoid damaging the threads of the pinion if it is to be reused.*

(a) Place the pinion in a vice with soft jaws, holding the flats, adjacent to the collar locking rollers.

(b) Using a cold chisel, cut one half to two thirds into the locking collar at points "B" and "C". (as shown in Fig.7).

(c) Reposition the pinion in the vice and chisel down the splines into the cuts made at points 'B' and "C". A few hefty blows will fracture the locking collar enabling it to be removed.

5. Remove the oil slinger. (Item 2 in Fig.8).
6. Remove the sleeve pinion assembly, pinion and the bearing cone. (Item1 in Fig. 8).

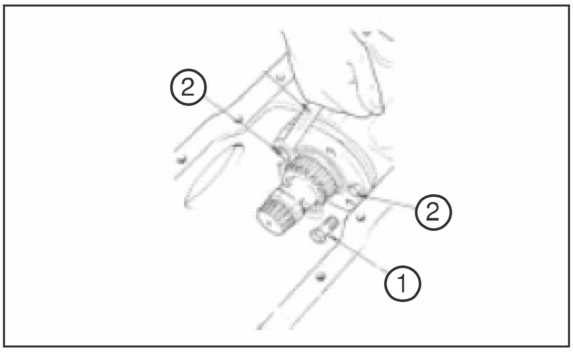

Fig.6

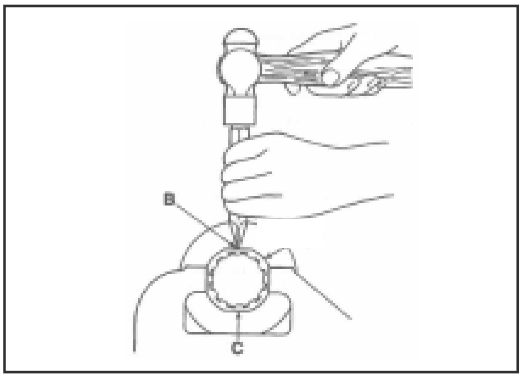

Fig. 7

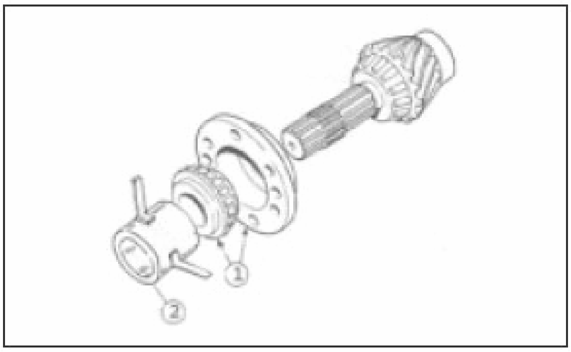

Fig. 8

7. Use a hand or hydraulic press and remove the front taper roller bearings. (Fig. 9).

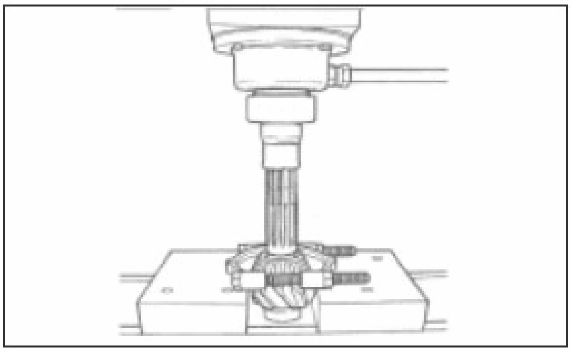

Fig. 9

8. Remove the snap ring securing the pilot bearing to the pinion using a circlip plier.
9. Remove the pilot bearing in a press (Fig.10).

Examination :

Examine all components for signs of wear, scoring or pitting. Any faulty or worn parts must be replaced.,

***NOTE** :*

(a) If the pinion is damaged the crown wheel must also be replaced as these are only supplied in matched sets.

(b) If the taper roller bearing needs replacement it should be replaced as a set (i.e. cup and cone).

(c) New snap rings should always be fitted.

Reassembly

Pinion

1. Press the pilot bearing on to the pinion (Fig.11).
2. Secure the pilot bearing with a new snap ring.
3. Press the taper roller bearing on to the pinion (SER / 059 / 056). (Fig. 12).
4. Locate the pinion in its housing and fit the front bearing cone.
5. Refit the oil slinger in position. Fit a new locking ring and hand tighten.
6. Hold the housing in a soft faced vice.
7. Fit the preload gauge, SER / 064 to the pinion and tighten the locking ring to give a preload reading of 2 - 2.5 Nm (18 -22 lbf inch). (Fig.13).

   Set the weight on gauge T 4062 A so that when the preload is correct the arm will just fall under its own weight with a light touch of the finger.
8. Remove the gauge, tap the pinion firmly to centralise the bearings, then recheck the preload.
9. Secure the locking ring by driving a locking roller down either side of one of the pinion splines. (Item 1 in Fig.14).

***NOTE :** The locking rollers must be driven flush, with the collar.*

Before re fitment, the pinion assembly should be freely lubricated with clean transmission oil.

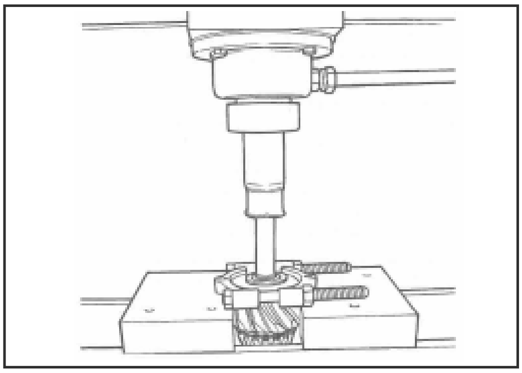

Fig.10

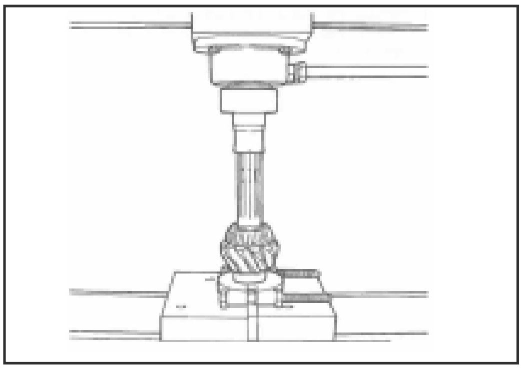

Fig. 11

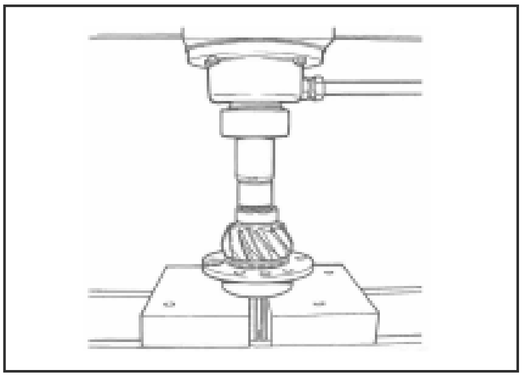

Fig. 12

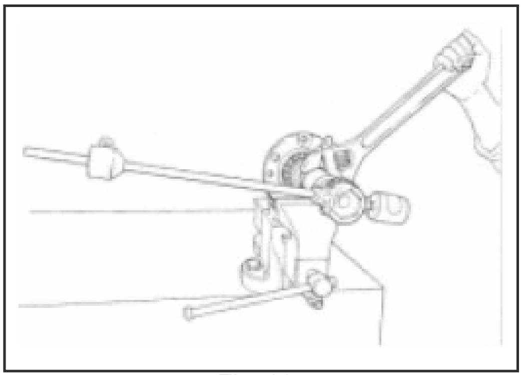

Fig. 13

(a) Ensure that the dowel pin in the sleeve Pinion is aligned with the hole in the centre housing before driving the sleeve into place.

(b) Tighten the six bolts to a toque of 102–108 Nm (75 - 80 lbf.ft).

Pinion Preloading (With Double Lock Nuts)

1. Using the lock nut "C" spanner (SER 060) and preload checking gauge (T 4062 - A) aid tighten the pinion lock nut till it reaches the face of the bearing (Fig. 14A).

   NOTE : *Few drop of oil to be applied on the sleeve bearing before tightening.*

2. Fix the pinion pre-load gauge to the pinion and position the weight at the 18 inch scale position. Tap the scale. The tool should come down. If not adjust the lock nut tightening accordingly. The tool should come down only when it is tapped and not on its own (Fig. 14B).

3. Position the weight at the 22 inch (558.8 mm) scale position and tap the scale. The moment the scale is tapped the tool should come down smoothly without any interruption. If not, adjust the locknut accordingly using "C" spanner and pre-load checking gauge.

4. Insert tab washer, assemble the second lock nut and tighten to 2 - 2.5 Nm (18 to 22 lbf inch). Recheck the pre-load and then bend the tab washer in the slot given on both lock nuts.

   Note : *1. Repeat the procedure 2 to 3 times and on occasion drive the pinion with the dead-blow hammer to ensure the pinion freely rotates.*

   2. Tap the scale by using finger only.

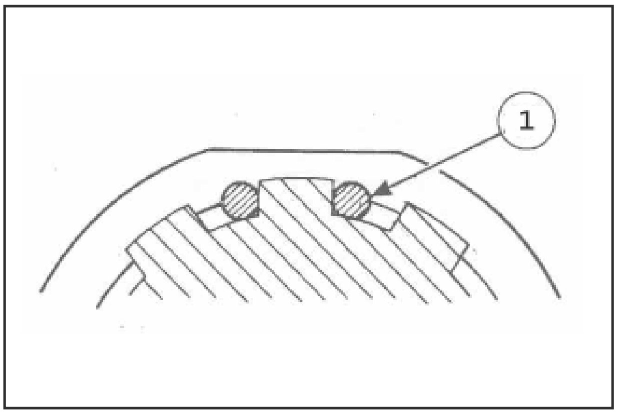

Fig. 14

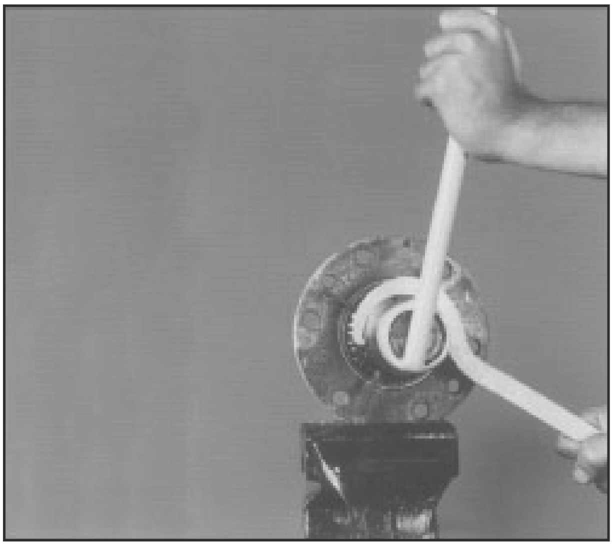

Fig. 14 A

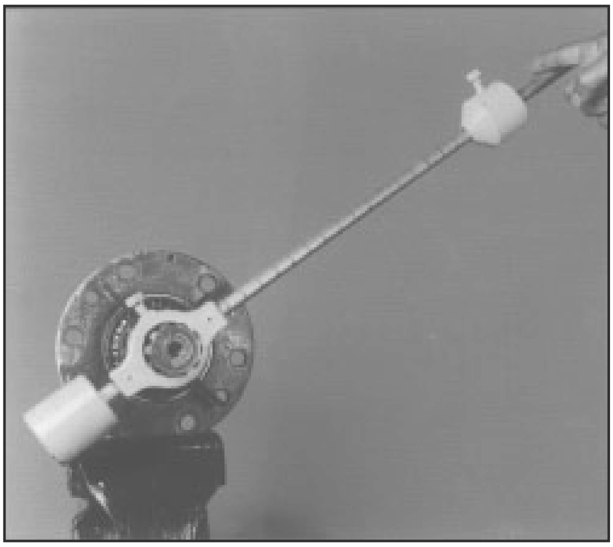

Fig. 14 B

Crown Wheel :

1. Ensure that the mating faces of the differential case and the new crown wheel are perfectly flat. (Item 1 in Fig.15)
2. Fit the left hand differential case, with the mating face upwards in a bench plate (SER / 017 / 018) (Item 2 in Fig.15)
3. Decrease the crown wheel, left hand differential case, differential bolts and nuts.
4. Collect together all items necessary for speedy assembly.
5. Open epoxy resin kit, its contents are one jar containing 10 ml. of resin. This jar is also used as a mixing vessel). One jar containing 5 ml. of hardener .One glass stirring rod one brush.

WARNING : Avoid excessive or repeated skin contact. Observe the directions on the container.

NOTE : *Operations 6 -12 that follow, must be completed within 30 minutes of mixing the resin and hardener.*

6. Pour the hardener into the resin jar and mix thoroughly using the glass rod. .
7. Apply an even coating of adhesive to both Item 1 not shown for crown wheel bottom mating surfaces. (Item 1 in Fig.16).
8. Press the differential case on to the crown wheel.

NOTE : *These two components are an interference fit and must, therefore, have their bolt holes aligned accurately before being fitted together.*

9. Fit the twelve bolts (Item 2 in Fig.16) with their heads nearest the crown wheel teeth.
10. Apply two drops of Stud lock (Loctite 270) to the first thread of each bolt.

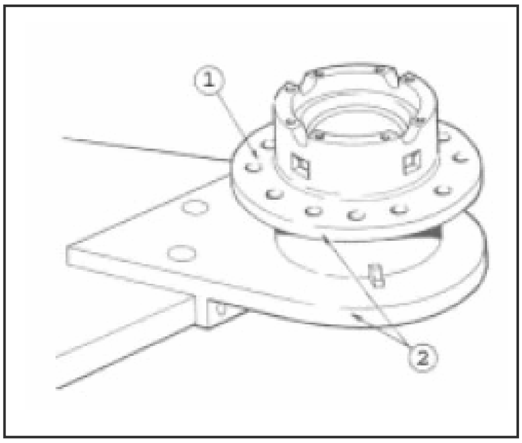

Fig. 15

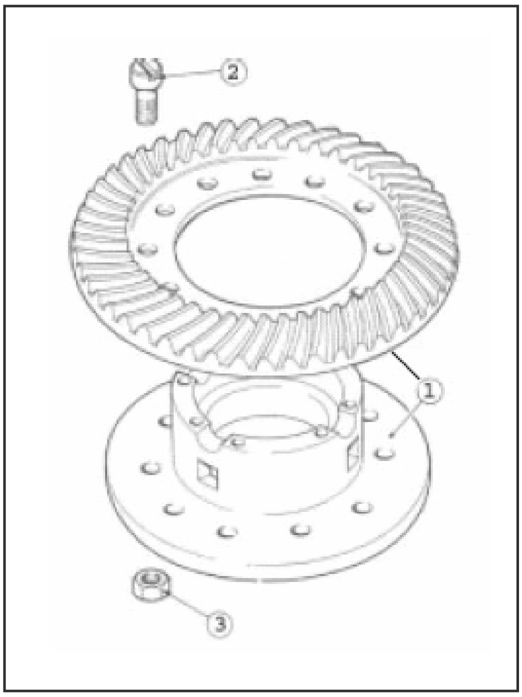

Fig.16

11. Fit the nuts and tighten them progressively and evenly to a torque of 160 Nm.(118 lbf.ft.) (Item 3 in Fig.16).
12. Refit the differential components.
13. Cure the resin bonding by subjecting the differential assembly to uniform heating as follows.

    120°C (248°F) for a minimum of 1 hour

    or 40° C (104°F) for a minimum of 12 hours.

    or 30° C (86°F) for a minimum of 16 hours.

    or 20°C (60°F)for a minimum of 24 hours.
14. Press on the right hand differential bearing cone.
15. Press in the left hand differential bearing cone.
16. Refit the differential unit on to the centre Housing.
17. Refit the left hand Axle housing.
18. Set the differential bearing preload if differential. bearings / differential.case / crown wheel pinion is changed. (See Operation No.10A.1.5 below)
19. Refit the axle housing assembly, lift cover assembly on the centre housing and assemble the rest of the tractor. Adjust the brake.
20. Refill the transmission with oil.
21. Road test the tractor and inspect for oil leaks.

    ***NOTE :** Since hydraulic lift cover has been removed and refitted it is necessary to recheck the hydraulic settings.*

10A.1. 5 DIFFERENTIAL PRE-LOAD

Check

Special Tools

Preload Gauge (SER/112) (Fig. 17).

***Note :** This check must be carried out whenever the differential unit is disassembled, or if the bearings have been replaced.*

Procedure

1. All preload check are made on the right hand side.
2. Assemble the left side axle housing assembly.
3. Do not fit the bearing cup to the right hand axle housing.
4. Centrally position the centraliser along with bearing cup over the differential case right-hand taper roller bearing. (Fig.18)

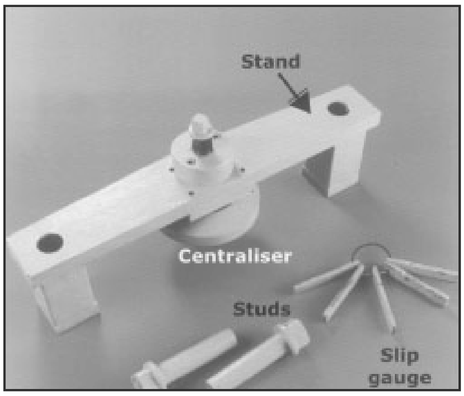

Fig. 17

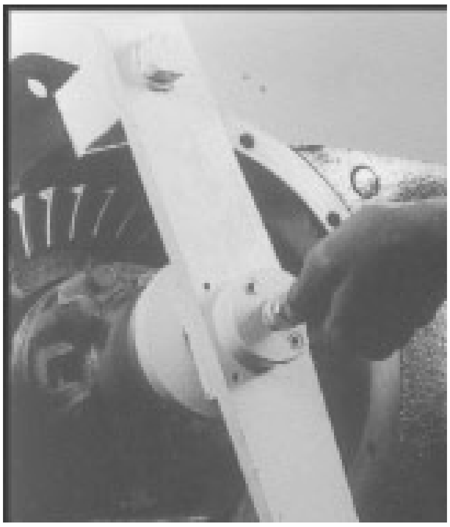

Fig. 18

5. Fix the tool stand to centre housing using 2 studs (Fig.18) and tighten the centre nut to a torque of 25 Nm (18 lbf.ft.).

   Ensure the tool seating area on the center housing is clean and without axle housing gasket.

6. Measure the gap between the tool stand and tool Centraliser using Slip Gauge. The gap measured by slip gauge determines the shim thickness. (Fig. 19).

   Note :

   (a) *Ensure proper seating of tool stand on the Centre Housing.*

   (b) *Do not overtighten the centre nut of the tool.*

   (c) *Slip gauge should enter freely in the gap. Note the slip gauge number and select the shim from the table corresponding slip gauge number.*

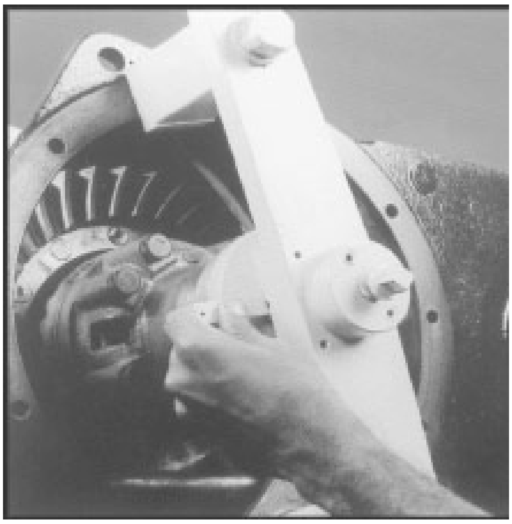

Fig. 19

Slip gauge No	Shim Thickness		Part number	Identification mark
	mm	inch		
A	1.24 - 1.30	0.048 - 0.051	715 631 M1	5 cuts
B	1.12 - 1.17	0.044 - 0.046	715 632 M1	4 cuts
C	0.99 - 1.04	0.038 - 0.040	715 633 M1	3 cuts
D	0.86 - 0.91	0.033 - 0.035	715 634 M1	2 cuts
E	0.74 - 0.79	0.029 - 0.031	715 640 M1	1 cuts
F	0.61 - 0.66	0.024 - 0.025	715 692 M1	No cut

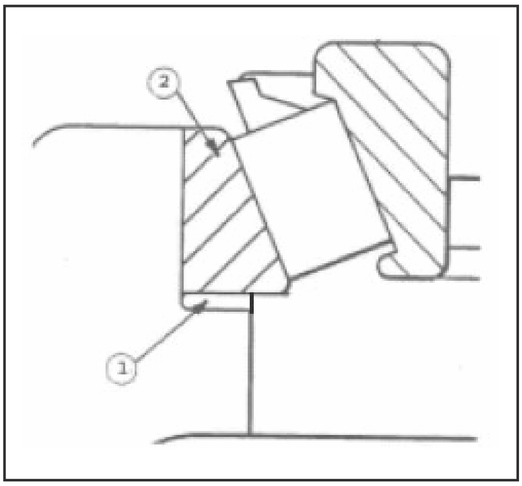

Fig. 20

7. After selecting the shim, remove the tool assembly from centre housing and the Cup Bearing. Fit the selected shim (Item1 in Fig. 20) behind the Cup Bearing (Item 2 in Fig. 20) on the Axle Housing right-hand in the usual manner.

8. Refit the bearing cup, ensuring that it is fully seated.

9. Refit the right- hand Axle housing.

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SECTION 10

Part B

REAR AXLE AND OIL IMMERSED BRAKES

REAR AXLE AND BRAKES

Operation no	Description	Page No
-----------	Specification	
10B.1	General description	10B - 4
10B.2	Rear wheel stud	10B - 6
10B.3	Epicyclic unit outer housing and ring gear	10B - 6
10B.4	Epicyclic planet and sun gear	10B - 7
10B.5	Epicyclic unit	10B - 8
10B.6	Epicyclic preload	10B - 12
10B.7	Axle housing left-hand side	10B - 14
10B.8	Axle housing right-hand side	10B - 16
10B.9	Axle shaft - Direct drive wet brakes	10B - 17
10B.10	Left-hand carrier plate	10B - 18
10B.11	Right-hand carrier plate	10B - 18
10B.12	Left-hand brake actuator housing	10B - 19
10B.13	Right-hand brake actuator housing	10B - 20
10B.14	Brake adjusting and balancing	10B - 21
10B.15	Left-hand brakes servicing	10B - 22
10B.16	Right-hand brake servicing	10B - 24
10B.17	Differential lock actuator mechanism	10B - 25
10B.18	Differential lock coupler cap	10B - 26
10B.19	Differential lock preload checking and adjustment	10B - 27
10B.20	Right-hand differential bearing	10B - 29
10B.21	Differential unit	10B - 29
10B.22	Differential bearing left-hand	10B - 30
10B.23	Differential unit	10B - 31
10B.24	Crown wheel	10B - 32
10B.25	Pinion assembly	10B - 33
10B.26	Rear drive shaft	10B - 35
10B.27	Parking brake servicing	10B - 36

SPECIFICATION:

Crown wheel pinion ratio	3.4545:1
Type	Direct drive with 11 X 38 crown wheel pinion
Pinion preload	18 - 22 lbs.inch
Brake operation	Rods and levers.
Parking brake	Cable operated on both brakes indepedent of foot brake.

Special Tools:

SER / 054	Tractor splitting stand.
SER / 164	Drift
SER / 029	Adaptor.
SER / 028	Universal puller.
SER / 163	Bearing drive.
SER / 023	Differential bearing preload gauge.
SER / 024	Straight edge in conjuction with SER / 023.
SER / 162	Bearing driver.
SER / 017	Holder.
SER / 018	Bench Adaptor.
SER / 038	Hand press.
SER / 059	Adaptor.
SER / 056	Adaptor.
SER / 061	Pre - Load gauge.
SER / 022	Needle roller bearing puller.
SER / 063	Needle roller bearing driver.
SER / 058	Universal Handle.
SER / 060	Pinion lock nut ‘C’ Spanner.
SER / 064	Preload checking gauge aid.
SER / 117	Extractor.
SER / 030	Bearing remover main tool.
SER / 225	Axle housing cup remover.
SER / 118	Preload checking tool.
SER / G / 204	To press cup on differential carrier left - hand.
SER / G / 207	To press cone on differential lock.
SER / G / 228	Plate differential carrier cone removal.
SER / G / 227	Differential case left - hand cup removal.
SER / G / 223	To press bush into the carrier

SER / G / 224	...	Carrier bush pusher
SER / G / 194	...	Adaptor.
SER / G / 195	...	Adaptor
SER / G / 196	...	Bearing cup and seal remover.
SER / G / 198	...	Bearing cup assembler.
SER / G / 197	...	Seal replacer.
SER / G / 199	...	Bearing cone remover.
SER / G / 200	...	Bearing cone remover.
SER / G / 201	...	Bearing replacer.

Bolt torques:

Rear Wheels nuts	...	200 lbf.ft (270 Nm)
Epicyclic unit housing bolts	...	55 lbf.ft (75 Nm)
Stabliser mounting bolts	...	170 lbf.ft (230 Nm).
Differential case mounting bolts	...	80 lbf.ft (108 Nm)
Centre mounting bolts	...	18 lbf.ft (25 Nm)
Sleeve mounting bolts	...	118 lbf.ft (160 Nm)

10B . 1 GENERAL

The drive from the Transmission mainshaft is transmitted through the rear drive shaft and shear tube to a spiral bevel driving pinion and crown wheel, then through the axle shafts to the rear wheel axles.

The driving pinion is supported in the centre housing by a straight roller pilot bearing and a pre-loaded housing assembly carrying two taper roller bearings.

The Crownwheel is attached to the split differential case, which is supported on each side by a tapper roller bearing. The differential pinions run on a cross joint and thrust is taken by thrust washers behind the pinions.

The axle shaft inner ends are splined into differential gears, and the outer ends are mounted in rear wheel disc.

This tractor is fitted with multi-disc oil cooled brakes between the axle housings and the differential carrier plates adjacent to the centre housing.

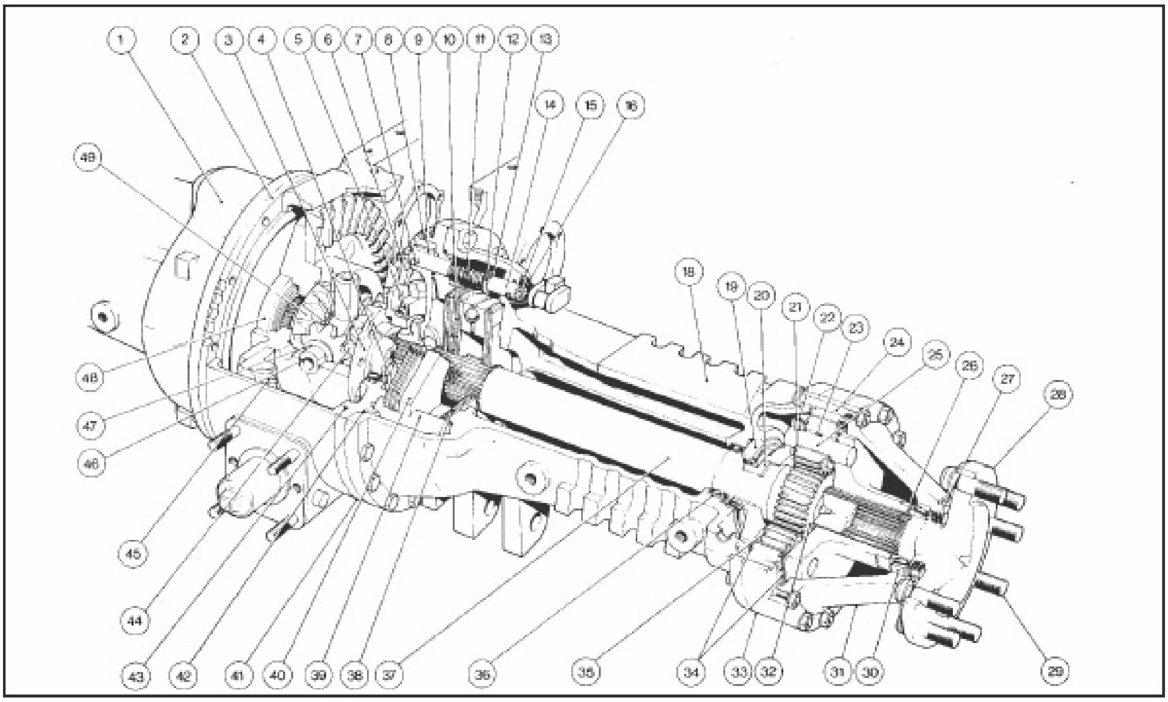
The brakes are operated by two independently operated pedals located on the right of the transmission housing.

The right pedal operates the right hand brake and the left pedal operates the left hand brake, to assist turning.

For off-field use, the brakes are used together by operating an interlocking latch which joins the two brake pedals.

When only single brakes are applied on the tractor the parking brake also actuates these disc brakes.

Pressure on the brake pedal brings an actuating assembly in contact with two rotating middle (friction) discs splined to each axle shaft, these in turn contact fixed friction faces provided in the axle housing and in the differential carrier plate fitted between the centre and axle housings. The mechanism of each brake consists of two cast iron actuating disc, held together by tension springs and separated by steel balls located in inclined seats. Pressure on the brake pedal, pulling on the operating rod, rotates one actuating disc relative to the other, and the steel balls ride up their inclined seats and so spread the actuating disc apart. These come into contact with the rotating (friction disc), which are splined to the shaft being braked. The actuating assembly will move slightly in the direction of rotation until the torque ear of the one actuating disc comes into contact with a shaft in the housing. The other actuating disc tends to rotate further, increasing the angular displacement between the discs, and assisting the braking action. When the operating pull is released, the tension springs cause the discs to return to their normal position.



Key to Figure – 1

1	Axle Housing- Left-hand	18	Axle Housing – Right-hand	34	Gasket
2	Carrier Plate - Left-hand	19	Epicyclic Hub-Inner bearing	35	Planet Gear
3	Differential lock Coupler cap	20	Epicyclic hub – bush	36	Inner Oil seal
4	Differential lock Coupler	21	Thrust Washer	37	Axle shaft
5	RH Differential bearing	22	Roll pin	38	Brake friction plate
6	Pinion Assembly	23	Needle rollers	39	Brake stop rod
7	Roll pin	24	Epicyclic unit securing bolts	40	Actuator unit
8	Ground Speed gear	25	Planet gear-shaft	41	Carrier plate-Right-hand
9	Differential lock coupler fork	26	Half ring	42	‘O’ ring- Outer
10	Brake interplate	27	Outer oil seal	43	‘O’ ring- Inner
11	Differential lock return spring	28	Stub axle	44	Differential gear-RH
12	Washer	29	Wheel stud	45	Crown wheel
13	Circlip	30	Outer Bearing	46	Cross shaft
14	Differential lock actuating shaft	31	Cover Rear Drive	47	Thrust washer
15	Differential lock adjusting nut	32	Sun gear	48	Differential Bearing
16	Dust cover	33	Ring Gear	49	Differential Gear-Left-hand

10B . 2 REAR WHEEL STUD

Removal and Replacement

Removal

1. Jack up the tractor.
2. Remove the rear wheel
3. Drive out the damaged stud.

   Examine the stud hole, the other studs and the wheel disc for signs of fretting or damage.

Refitment:

4. Locate a new stud in the wheel axle.
5. Tap the stud gently to locate the splines.
6. Fit a new wheel nut, with the flat side against the axle to the stud and pull the stud through the axle to its correct position.
7. Remove the nut.
8. Refit the rear wheel and nuts and tighten the nuts progressively and evenly to a torque of 200 lbf.ft (270 Nm).

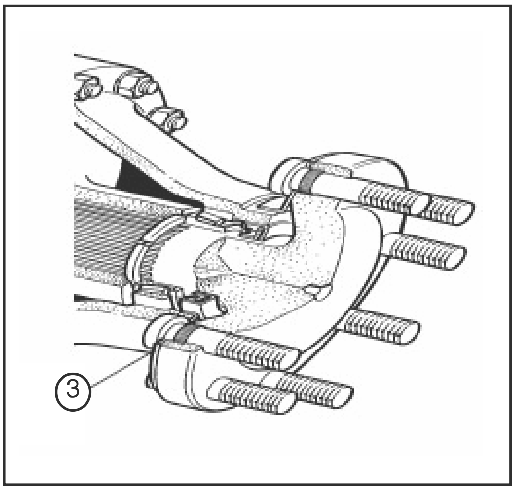


Fig 2

10B.3 EPICYCLIC UNIT OUTER HOUSING AND RING GEAR

Removal and Refitment

Removal

1. Apply the parking brake.
2. Jack up the tractor.
3. Remove the rear wheel.
4. Scribe a mark across the outer housing, ring gear, and axle housing to facilitate refitment. Also scribe a mark across the outer housing and ring gear only, this will ensure that the ring gear is replaced with the teeth in full engagement.
5. Remove the nuts and bolts.
6. Remove the outer housing and ring gear assembly.
7. Remove the ring gear.

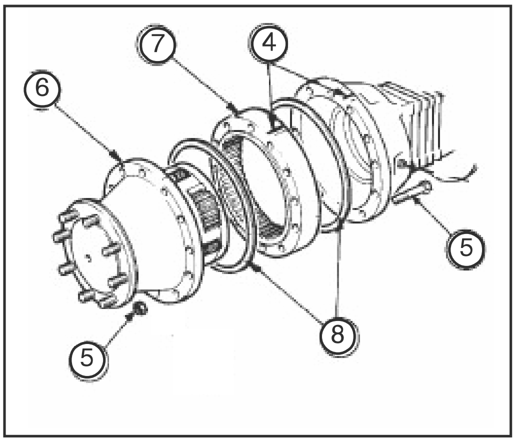


Fig 3

***Note:** Do not withdraw the axle shaft.*

8. Remove and discard the two cork gaskets. Clean the recesses in which the ring gear spigots are located and check that there is no burr or deformity which could cause leakage.

Refitment

10. Reverse procedure 1 to 8 except:
    a. Fit new cork gaskets.
    b. Ensure that the scribe marks are correctly aligned ensuring that the teeth of the ring gear are in full engagement, otherwise severe damage can occur.
    c. Tighten the nuts and bolts to a torque of 55 lbf ft (75 Nm).
    d. Refill to the correct level with an approved oil.

10B.4 EPICYCLIC PLANET AND SUN GEAR

Servicing

Special Tools : 3/8 inch UNF bolt

Disassembly

1. Remove the outer housing assembly. (See operation 10B.3) To service the sun gear it is only necessary to remove one planet gear.

   ***Note :** The sun gear will come out through only one of the planet gear operation. It is wider than the other two.*
2. Drive out and discard the roll pin.
3. Fit the 3/8 inch bolt to the planet gear shaft.
4. Withdraw the shaft trying not to dislodge the needle rollers.
5. Remove the 3/8 inch bolt.
6. Remove the thrust washers and the planet gear. Repeat operations 2 to 6 only if the epicyclic hub is to be completely overhauled.
7. Withdraw the sun gear. Inspect all parts and replace any which show signs of undue wear or damage.

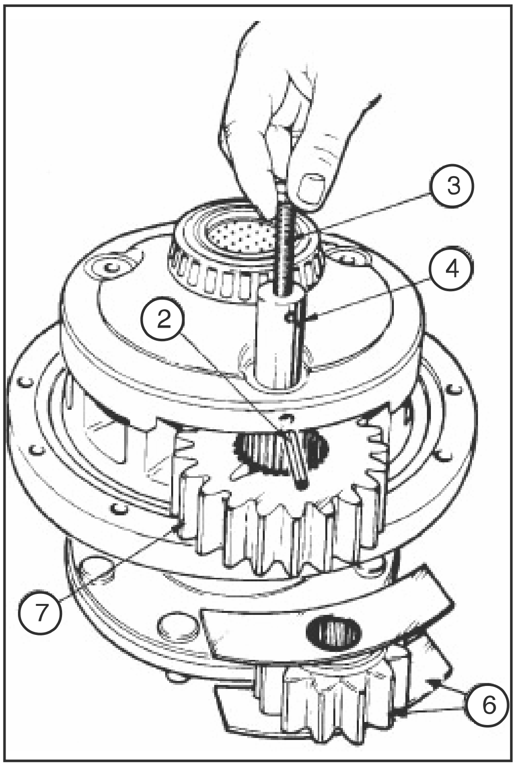


Fig 4

Reassembly

8. Reverse procedure 1 to 7 except:

   a) If the needle rollers are dislodged, refit them using petroleum jelly, not grease. There are 58 needle rollers per planetary gear (two rows of 29, plus a spacer washer).

   b) Ensure that the holes in the casting and shaft are aligned.

   c) Fit a new roll pin.

   d) The wider opening for the removal of the sun gear has special wide thrust washer. Ensure that they are fitted to the correct planetary gear.

   ***Note :** Planetary gears must be fitted with the larger shoulder facing the centre at the axle.*

10B.5 EPICYCLIC UNIT

Servicing

Special tools :

a. SER/028 - Differential bearing remover.
b. SER/029 - Base
c. SER/038 - Hand press
d. SER/G/223 - To press bush into carrier
e. SER/G/224 - Carrier bush pusher
f. SER/G/194 - Adaptor
g. SER/G/195 - Adaptor
h. SER/G/196 - Bearing cup and seal remover.
i. SER/117 - Extractor
j. SER/G/198 - Bearing cup assembler
k. SER/030 - Bearing remover (Main tool)
l. SER/225 - Axle Housing cup remover.
m. SER/058 - Drive Handle
n. SER/G/197 - Seal replacer
o. SER/G/199 - Bearing cone replacer
p. SER/G/200 - Bearing cone replacer
q. SER/G/201 - Bearing replacer

Disassembly

1. Remove the planetary gear and sun gear. (See operation 10B.4)
2. Remove the bearing cone using SER/029 and SER/G/194.
3. Normal Duty Axles: Tap the bearing bush into the hub using SER/G/223
4. Normal Duty Axles: Remove the bush and SER/G/224 from the hub.
5. Place the dismounted wheel on the workshop floor.
6. Fit the outer housing and hub assembly and secure with two wheel nuts.
7. Fit SER/117 and remove the hub from the housing.
8. Remove the two half rings.
9. Using SER/038 and SER/G/195 press out the wheel axle.
10. Lift out the bearing cone.

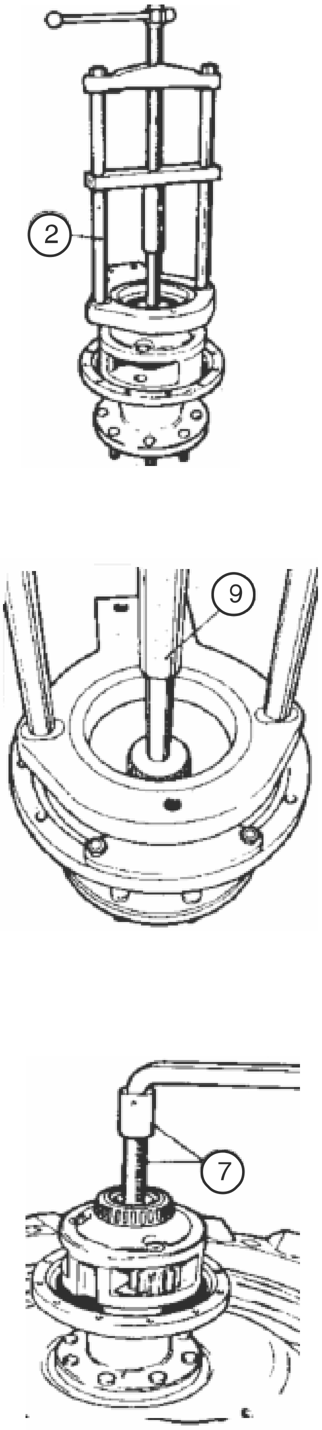


Fig 5

11. Tap out the outer seal. Using special tool SER/G/196.

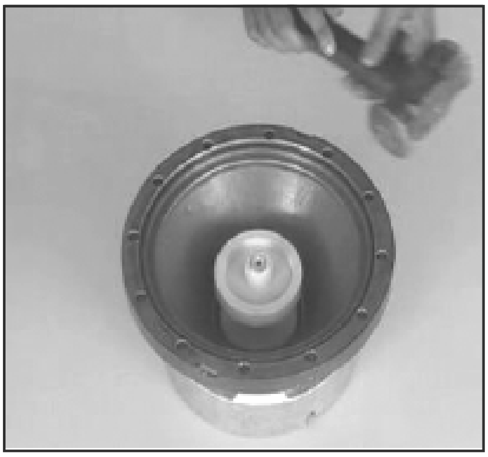


Fig 6

12. Tap out the bearing cup. Using special tool SER/G/196.

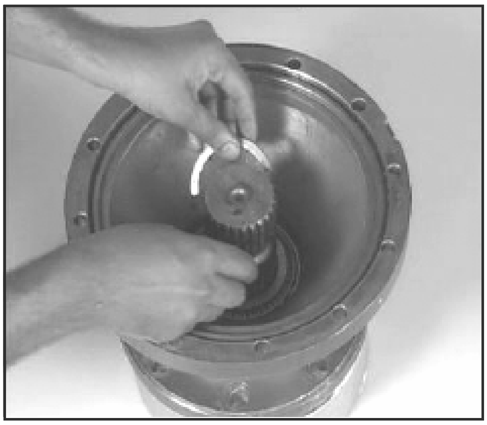


Fig 7

13. Fully apply the parking brake and check that the transmission oil is no higher than the FULL mark on the dipstick. Remove the axle shaft.
14. Using SER/G/225, remove the inner bearing cup and shims.
15. Inspect all parts and replace any which show signs of undue wear or damage. Replace all seals and gaskets.

Reassembly

16. Using SER/G/198 Refit the bearing cup, making sure it is fully seated.

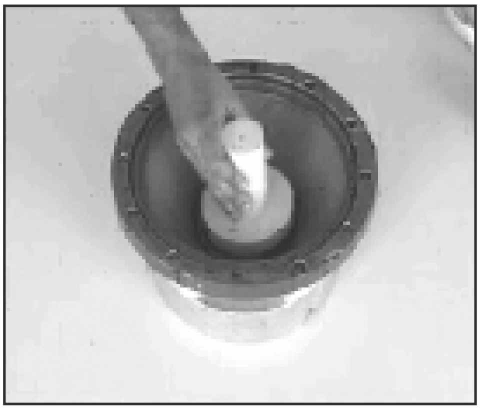


Fig 8

17. Smear a new outer seal lightly with recommended “Loctite 243”, then drive it into the housing using SER/G/197 metal face outwards, and 0.080 inch (2 mm) above the housing (dimension A). Smear the lip, and fill the seal cavity with petroleum jelly.

Note :

Allow the Cone assembly undisturbed for 72 hours for the seal to get firmly located in its position.

18. Carefully, insert the wheel axle through the outer seal.

19. Using SER/G/199 drive the bearing cone fully onto the wheel axle, seating the rollers in the cup.

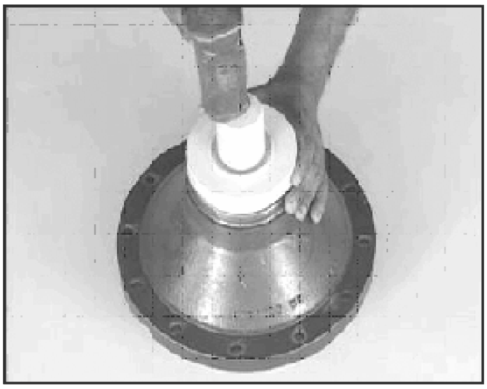


Fig 9

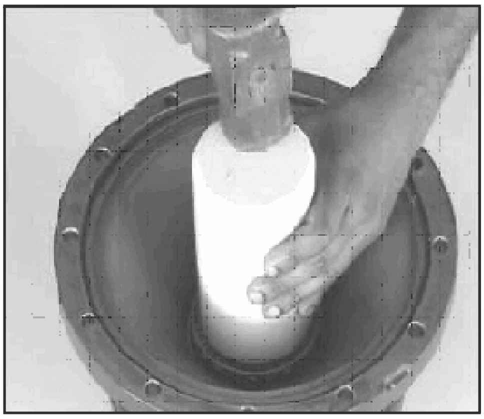


Fig 10

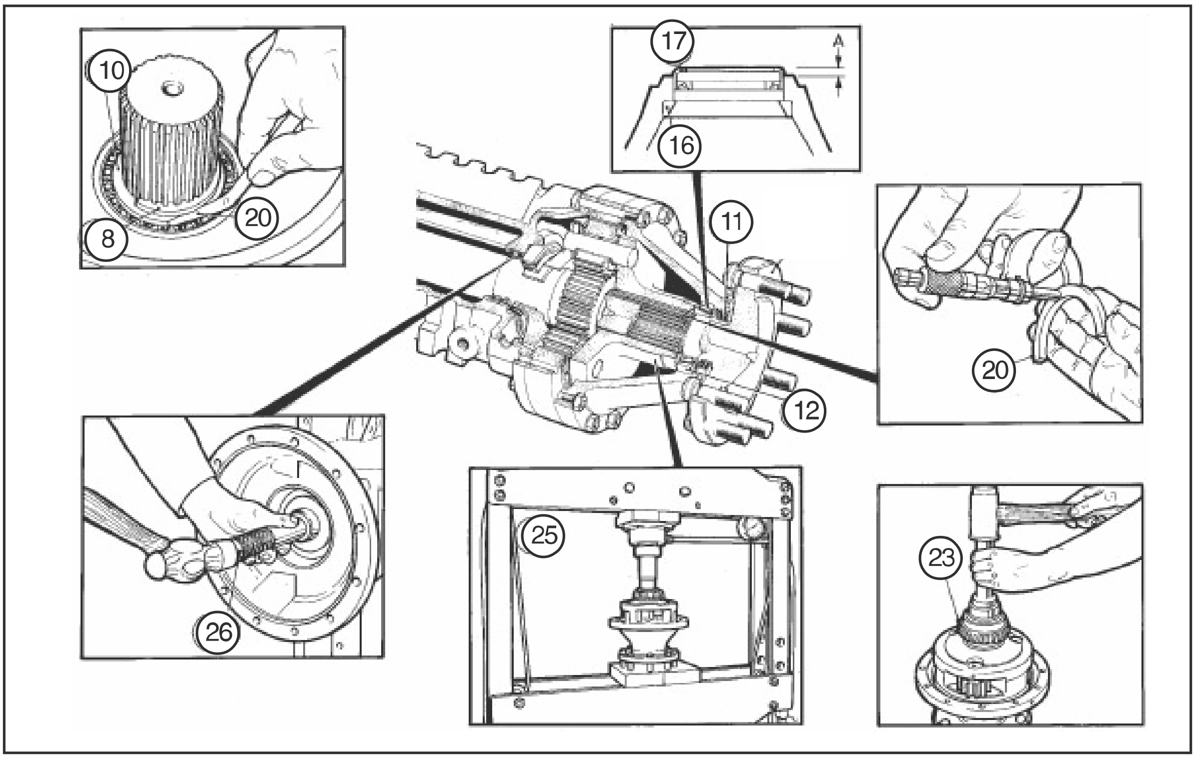


Fig 11

NORMAL AXLES

Using the number 0 half ring and feeler gauges measure the gap between the bearing cone and the half ring. If there is no clearance, the No. 0 half ring can be used. If the clearance is measurable, select a pair of half rings to give a clearance of 0.00 to 0.001 inch (0.00 to 0.025 mm) by using the following procedure and the table below.

Half ring	Feeler gap	Half ring thickness		Part No.	Identification No.
mm	inch	mm	inch		
5.92	0.233	5.84	0.230	882601M1	0
5.94	0.234	5.89	0.232		
5.95	0.2341	5.90	0.2321	882602M1	1
5.99	0.236	5.94	0.234		
6.00	0.2361	5.95	0.2341	882603M1	2
6.04	0.238	5.99	0.236		
6.05	0.2381	6.00	0.2361	882604M1	3
6.09	0.240	6.04	0.238		

a. Using a micrometer, measure the thickness of the No. 0 half ring.

b. Add the No. 0 half ring thickness to the feeler gauge measurement to give the thickness of the half rings required.

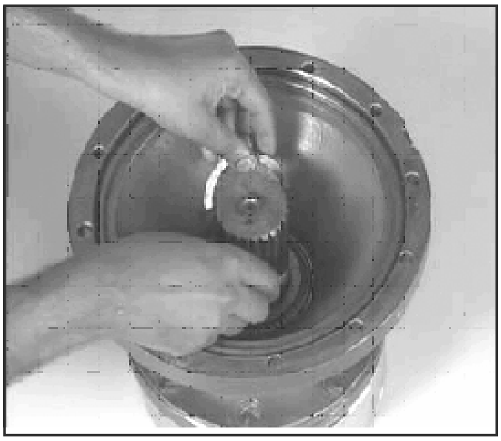


Fig 12

21. Fit the two half rings, ensuring that they seat fully in the groove.

22. Using the SER/058 Drive handle, SER/G/200, drive the bearing cone onto the spigot on the epicylic hub.
23. Reassemble the planetary gears and the sun gear in the epicyclic hub.
24. Using the handle, SER/G/200 and a hydraulic press, drive the epicylic hub onto the wheel axle.
25. Check the epicyclic preload.
26. Refit the inner bearing cup and shim in the axle housing, using special tool SER/G/201.
28. Refit the ring gear and outer housing assembly. (operation 10B.3)

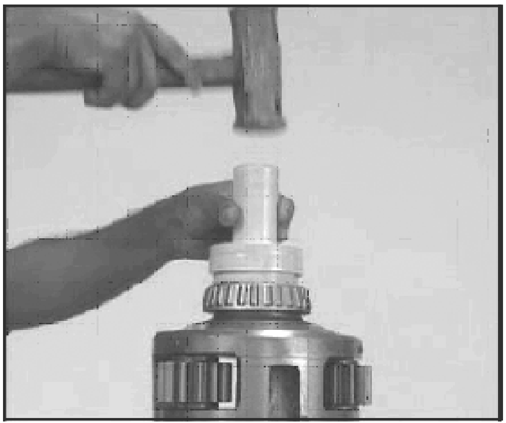


Fig 13

10B.6 EPICYCLIC PRE-LOAD

Special Tools :

SER/118	– Preload Checking tool
SER/028	– Puller
SER/029	– Base
SER/G/194	– Adapter

Procedure

1. Remove the outer housing and ring gear.
2. Remove the two cork gaskets and thoroughly clean the mating faces of the ring gear and outer housing.
3. Bolt the ring gear to the outer housing using four bolts from the epicyclic unit with four wheel nuts as spacers. These bolts should be equally spaced around the ring gear.

Note: Ensure that the ring gear is correctly fitted i.e., with the teeth in full engagement.

4. Ensure that the oil level is not higher than the FULL mark on the dipstick, fully apply the handbrake and remove the half-shaft.
5. **Normal / Axle**
   Using SER/028, SER/029 & SER/G/194 remove the inner bearing cup from the trumpet housing.
6. Remove the old shims.
7. Place the bearing cup on the spigot in the centre of SER/118. Do not fit the shims.
8. Place the epicyclic unit on SER/118 and measure the gap at points ‘A’ using two feeler gauges.
9. Note the clearance, which must be equal at both sides, then select shim or shims as per sizes from the table provided.

11.7 REAR AXLE EPICYCLIC PRE-LOAD TABLE

Gap Measured by Feeler Gauges (Both Sides)				Shim thickness required	
mm		inches		mm	inches
0.02	0.11	0.001	0.004	1.14	0.045
0.12	0.24	0.005	0.009	1.02	0.040
0.25	0.36	0.010	0.014	0.89	0.035
0.37	0.49	0.015	0.019	0.76	0.030
0.50	0.62	0.020	0.024	0.64	0.025
0.63	0.74	0.025	0.029	0.51	0.020
0.75	0.87	0.030	0.034	0.38	0.015
0.88	1.00	0.035	0.039	0.25	0.010
1.01	1.13	0.040	0.044	0.13	0.005
1.14	1.25	0.045	0.049	0.000	0.000

The shims are available as follows :

Shim Thickness		Part No.
mm	inches	
0.13	0.005	894757M1
0.25	0.010	894758M1
0.38	0.015	894759M1

10. Fit the shims to the axle housing.
11. Refit the inner bearing cup, ensuring that it is fully seated.
12. Refit the axle shaft.
13. Remove the four bolts and spacers securing the ring gear to the outer housing.
14. Using new cork gasket, refit the ring gear and outer housing. (operation 10B.3)

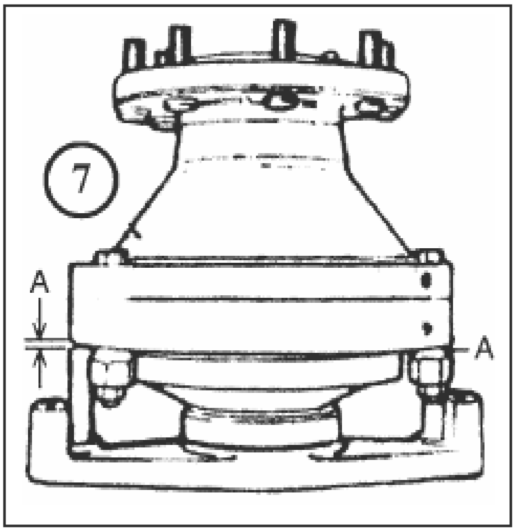


Fig 14

10B.7 AXLE HOUSING LEFT HAND

Removal and Refitment

Special tools : SER / 054 Tractor splitting stand.

Removal

1. Drain the transmission oil.
2. Release the lift rod at the knuckle.
3. Release the check chain at the check chain anchor bracket.
4. Release the stabilizer bracket underneath the axle housing.
5. Release the forward end of the lower link from the axle housing bracket.
6. Remove the lift arm and lower link assembly complete.
7. Release the brake pull rods and the return spring.
8. Jack up the tractor under the axle housing being serviced.
9. Remove the left hand rear wheel.
10. Place the SER / 054 tractor splitting stand under the centre housing and lower the tractor until the jack is just taking the axle housing weight.
11. Remove all the nuts and bolts securing the axle housing to the centre housing.
12. Lower the axle housing slightly and withdraw it far enough to clear the half shaft from the differential splines.
13. Withdraw the axle housing completely.
14. Remove the 'O' ring from the flange on the carrier plate.

Refitment

15. Reverse procedures 1 to 14 except:
    a. Fit a new 'O' ring, using petroleum jelly.
    b. When manoeuvering the axle housing assembly back into position, take care to align the axle shaft splines in the differential unit

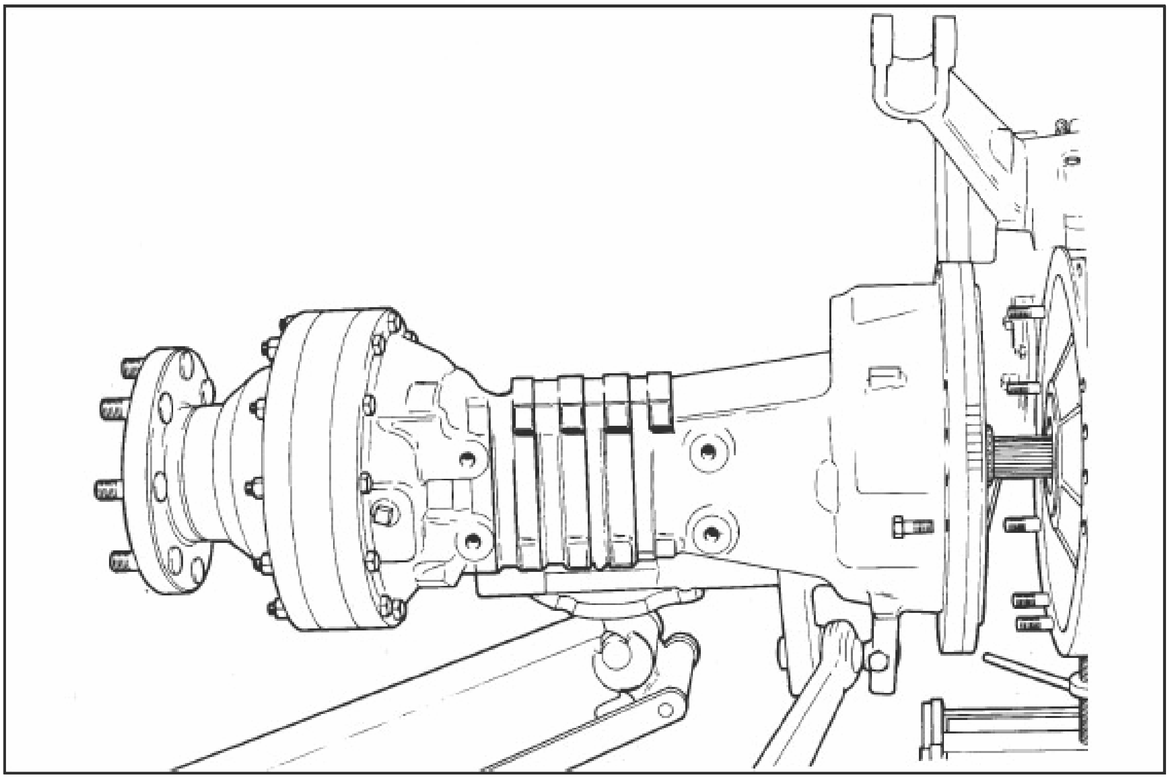


Fig 15

and the studs through their holes in the centre housing.

c. Apply a few drops of stud lock, then fit and tighten the stabilizer mounting bolts to a torque of 170 lbf ft (230 Nm).

d. Brush the wheel stud threads clean.

e. Refit the rear wheel and lightly oil the stud threads before fitting the wheel nuts.

Tractors fitted with 11/16 inch (17.5 mm) diameter studs.

Tighten the nuts progressively and evenly to a torque of 240 lbf ft (325 Nm).

> ***Note :*** *The full quantity of oil, as stated in the specification will not be required as approximately 0.66 gal (2.5 liter) will be trapped by the carrier plates in the axle housing.*

16. Adjust and balance the brakes.

10B.8 AXLE HOUSING RIGHT HAND

Removal and Refitment

Special tools : SER / 054 Tractor splitting stand

1. Drain the transmission oil.
2. Release the leveling box at the knuckle.
3. Release the check chain at the check chain anchor bracket.
4. Release the stabilizer bracket underneath the axle housing.
5. Release the forward end of the lower link from the axle housing bracket.
6. Remove the lift arm and lower link assembly complete.
7. Release the brake pull rods and the return spring.
8. Jack up the tractor under the axle housing being serviced.
9. Remove the right hand rear wheel.
10. Place the SER / 054 Tractor splitting stand kit under the centre housing and lower the tractor until the jack is just taking the axle housing weight.
11. Remove all the nuts and bolts securing the axle housing to the centre housing.
12. Lower the trumpet housing slightly and withdraw it far enough to clear the half shaft from the differential splines.
13. Withdraw the axle housing completely.
14. Remove the 'O' ring from the flange on the carrier plate.

Refitment

15. Reverse procedures 1 to 14 except:
    a. Fit a new 'O' ring using petroleum jelly.
    b. Carefully manoeuvre the axle housing into position, taking care to align the axle shaft splines in the differential unit and the studs through their holes in the centre housing.
    c. Apply a few drops of Loctite stud lock, then fit and tighten the cab stabilizer mounting bolts to a torque of 170 lbf ft (230 Nm).
    d. Brush the wheel stud threads clean.
    e. Refit the rear wheel and lightly oil the stud threads before fitting the wheel nuts.

Tractors fitted with 11/16 inches (17.5 mm) diameter studs. Tighten the nuts progressively and evenly to a torque of 325 Nm (240 lbf ft).

Note: *The full quantity of oil, as stated in the specification will not be required as approximately 0.66 gal (2.5 liter) will be trapped by carrier plate in the axle housing.*

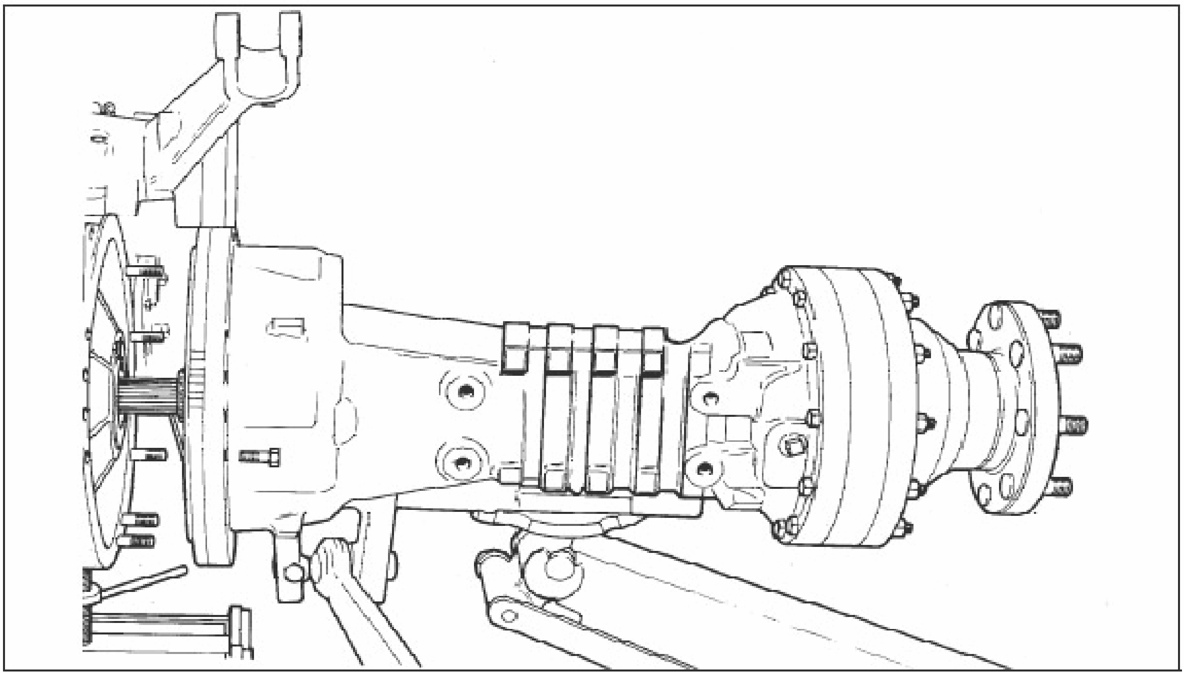


Fig 16

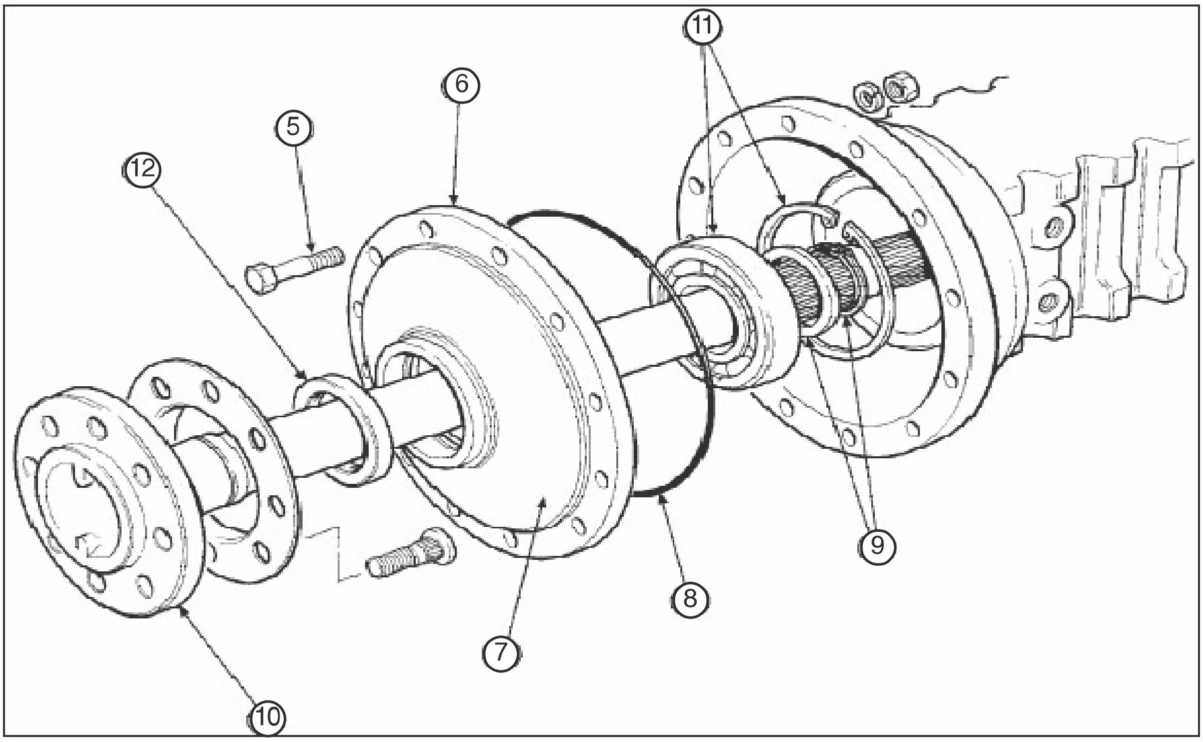


Fig 17

10B . 9 AXLE SHAFT – DIRECT DRIVE - WET BRAKES

Removal and refitment

> ***Note:*** *This Axle shaft which has a taper roller bearing retained by a shrink fit collar. It can be identified by the large ball bearing retained by a spacer and circlips.*

Removal:

1. Jack up the tractor under the axle housing to be serviced.
2. Drain the oil from the transmission.
3. Remove the rear wheel.
4. Ensure that the parking brake is hard on.
5. Remove the 12 nuts, bolts and spring washer.
6. Pry apart the axle housing between the end cover and axle housing.
7. Remove the axle and end cover assembly.
8. Remove the 'O' ring and discard.
9. Remove the external circlip and spacer.
10. Drive the axle shaft out of the bearing and cover assembly.
11. Remove the internal circlip and ball bearing if necessary.
12. Remove and discard the oil seal.

Refitment:

13. Coat the oil seal with MF lock and seal (Loctite 542) and press into the cover up to the shoulder.
14. Replace the ball bearing if necessary.
15. Refit the axle shaft, spacer and circlip.
16. Replace the 'O' ring.
17. Place the axle shaft into the axle housing. Carefully passing the shaft through the brake plates.
18. Refit the nuts and bolts tightening to a torque of 54 lbf.ft (74 Nm).
19. Refit the rear wheel and nuts, and then tighten the nuts progressively and evenly to a torque of 199 lbf.ft (270 Nm).
20. Refill the transmission with approved oil to the correct level.
21. Adjust the brakes.

10B.10 LEFT HAND. CARRIER PLATE

Removal and Refitment

Special tools : SER / 054 Tractor splitting stand.

Removal

1. Remove the axle housing(see operation 10B.7)
2. Manoeuvre the axle housing, off the jack and stand it on end.
3. Remove the two countersunk screws.
4. Withdraw the carrier plate from the axle housing.
5. Remove and discard the inner 'O' ring.

Refitment

6. Reverse procedures 1 to 5 except:

   a. Place a new 'O' ring in the recess in the axle housing using a smear of petroleum jelly for location. Do not attempt to fit the 'O' ring to the carrier plate.

   b. Secure each countersunk screw with a centre punch mark.

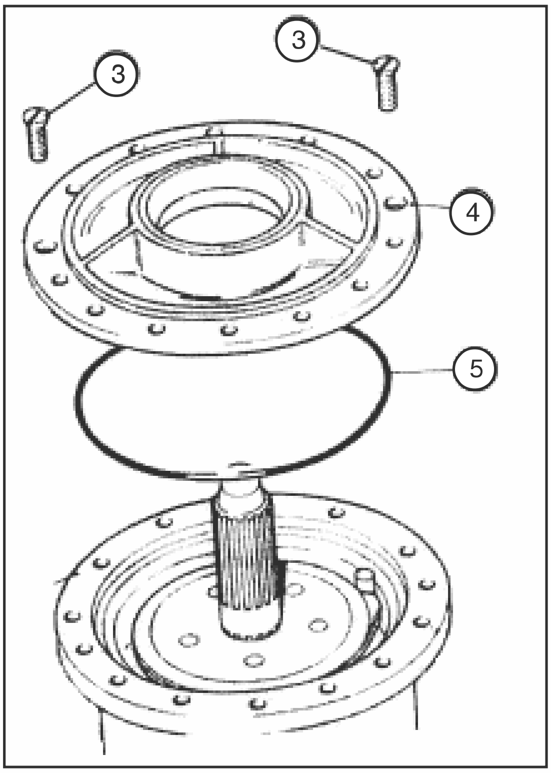


Fig 18

10B.11 RIGHT HAND CARRIER PLATE

Removal and Refitment

Special Tools: SER / 054 Tractor splitting stand.

Removal

1. Remove the axle housing(see operation 10B.8)
2. Manoeuvre the axle housing, off the jack and stand it on end.
3. Remove, and discard the roll pin.
4. Remove the two countersunk screws.
5. Remove the carrier plate complete with the differential lock coupler fork and coupler.
6. Remove and discard the inner 'O' ring.
7. Remove the differential lock coupler fork and coupler.

Refitment

8. Reverse procedures 1 to 7 except:

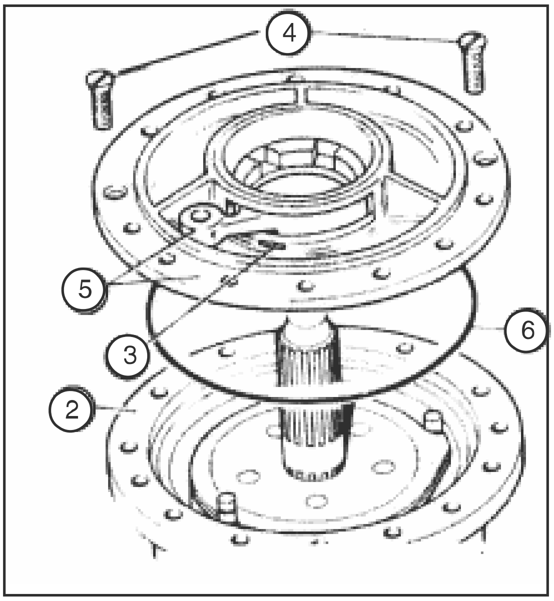


Fig 19

a. Fit a new ‘O’ ring to the recess in the axle housing using petroleum jelly. Do not attempt of fit the ‘O’ ring to the carrier plate.

b. Assemble the differential lock coupler fork and coupler to the carrier plate, then refit the assembly, aligning the coupler splines on the axle shaft and the coupler fork on its shaft. (if fitted)

c. Secure each countersunk screw with a centre punch mark.

d. Fit a new roll pin.

10B.12 LEFTHAND. BRAKE ACTUATOR HOUSING

(MECHANICAL BRAKES)

Servicing Tools : SER/164 - Drift

Disassembly

1. Drain the transmission oil to the MIN mark on the dipstick.
2. Disconnect the brake pull rods.
3. Remove the brake return spring.
4. Remove the locknut, nut and spacer.
5. Remove the three bolts and spring washers.
6. Remove the housing.
7. Remove and discard the gasket.
8. Tap out and, if damaged , discard the rubber boot.
9. If necessary, remove the brake pull lever by removing the split pin(9) and pushing out the pivot shaft (10).

Examination

Examine the mating faces of the actuator housing and the axle housing for damage. Clean both surfaces before reassembly.

Reassembly

10. Reverse procedures 1 to 8 except:
    a. If necessary fit a new rubber boot, preferable using a SER/164.
    b. Fit a new gasket.
    c. Before refitting the housing, smear the brake actuator rod with petroleum jelly. When refitting the housing take care to seat the lips of the rubber boot in the step on the actuator rod, without disturbing the garter spring.

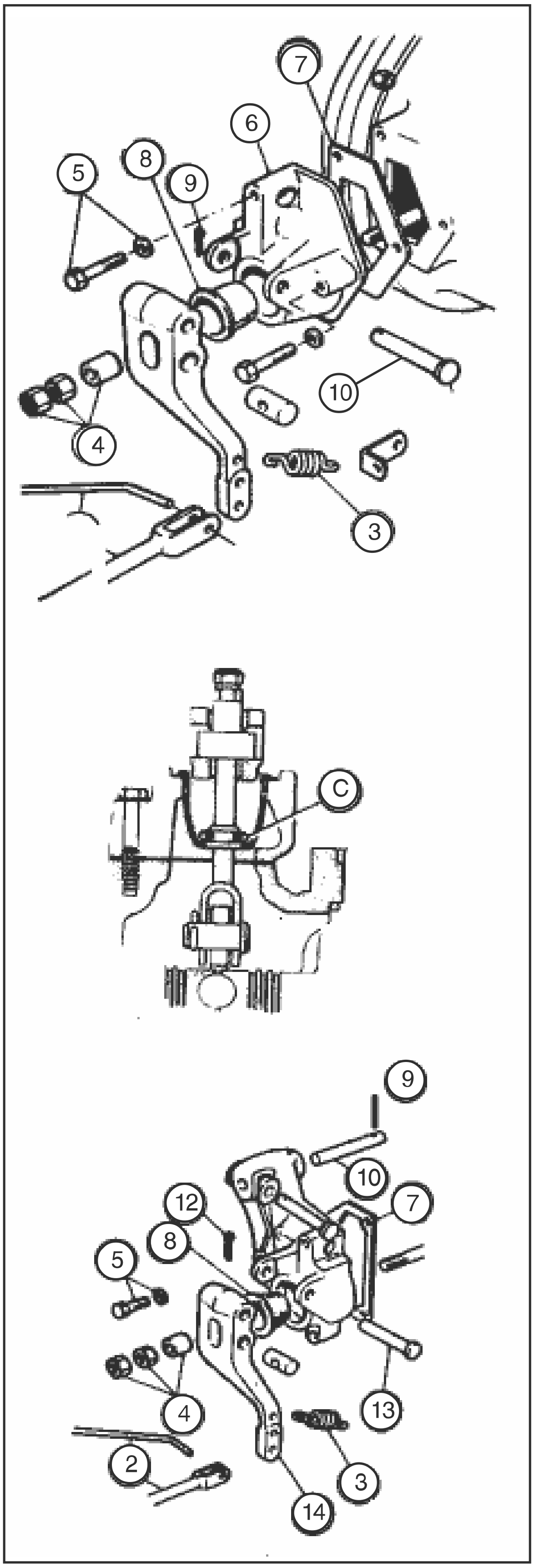


Fig 20

   d. The three bolts are of varying lengths according to their position in the actuator housing.

11. Adjust and balance the brakes.

10B.13 RIGHTHAND. BRAKE ACTUATOR HOUSING AND DIFFERENTIAL LOCK MECHANISM

(MECHANICAL BRAKES)

Servicing Tools : SER/164 - Drift

Disassembly

1. Drain the transmission oil to the MIN mark on the dipstick.
2. Disconnect the brake pull rods.
3. Remove the brake return spring.
4. Remove the locknut, nut and spacer.
5. Remove the three bolts and spring washers.
6. Remove the actuator housing complete.
7. Remove and discard the gasket.
8. Tap out and , if damaged , discard the rubber boot.

   Note: *Do not remove the differential lock lever mechanism or the brake pull lever unless they are to be serviced. (if fitted)*

Only If necessary continue as follows:

9. Tap out and discard the groove pin.
10. Remove the pivot pin.
11. Remove the lever assembly.
12. Remove and discard the split pin.
13. Push out the pivot shaft.
14. Remove the brake pull lever.
15. Examine the joint faces of the actuator housing and the trumpet housing for damage, clean both surfaces thoroughly before reassembly.

Reassembly

16. Reverse procedures 1 to 8 or 1 to 15 depending on the extent of disassembly except:
    a. If necessary, fit a new rubber boot, preferably using a SER/164.
    b. Fit a new gasket.

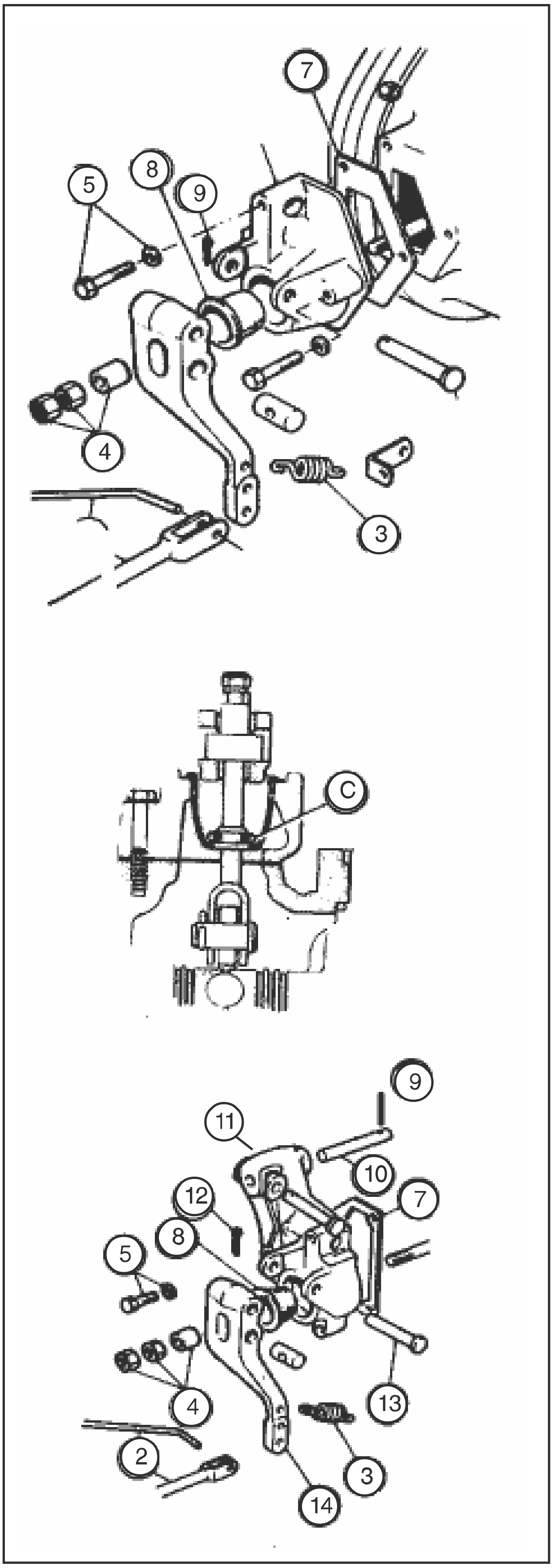


Fig 21

c. Before refitting the actuator housing, smear the brake actuator rod with petroleum jelly. When refitting the housing take care to seat the lips of the rubber boot in the step on the actuator rod, without disturbing the garter spring.

d. The three bolts are of varying lengths according to their position in the actuator housing.

17. Adjust and balance the brakes.

10B.14 BRAKE ADJUSTMENT AND BALANCING

Mechanical Actuation

Procedure is as follows:-
Brakes

Check the brakes every 250 hours, or more frequently if heavy work is involved.

Procedure to adjust the brakes:

a) Jack up the tractor until both rear wheels are clear of the ground.

b) Unlatch brake pedals.

Initial brake adjustment:

c) With the aid of an assistance, rotate one of the wheels forward slowly, at the same time tighten the adjuster nut (1) until the wheel just locks. The brake expander clearance is adjusted by unscrewing the adjuster nut (1) a number of flats based upon the number of friction disc.

MF 2615 = 9 flats (1-1/2 turns)

d) Repeat procedure for opposite side.

e) Road test the tractor, and check the brakes for binding or pulling to one side. Any tendency to pull to one side should be counteracted by slackening off the adjuster nut (1) on the side to which the tractor pulls.

CAUTION:

If, after the full adjustment procedure, brake operation is unsatisfactory, notify your Massey Ferguson Dealer immediately for investigation and rectification.

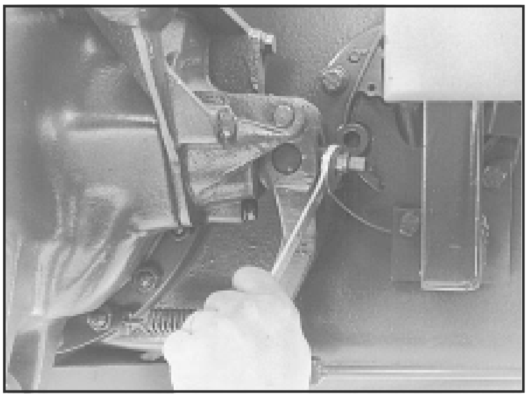


Fig 22

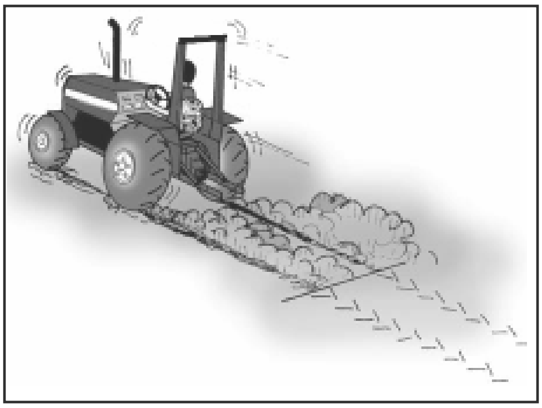


Fig 23

10B.15 LEFT HAND BRAKE

Servicing

Special Tools: SER / 054 Tractor splitting stand
SER/164 - Drift

Disassembly

1. Remove the left-hand axle housing. (see operation 10B.7)
2. Manoeuvre the axle housing assembly off the jack and stand it on end.
3. Remove the locknut, nut and spacer.
4. Remove the three bolts and spring washers.
5. Withdraw the actuator housing
6. Tap out and discard the rubber boot.
7. Remove the carrier plate. (see operation 10B.9)
8. Remove the brake components, turning each plate over and stacking in reverse order to ensure correct refitment.
9. If necessary, remove the brake stop rod from the housing.

Only if necessary dismantle the actuator unit as follows:

10. Release the four springs.
11. Remove the actuator rod and links and the ball bearings.

Examination

Friction plates : These have a minimum groove depth of 0.12 inch (0.3 mm) when new. When worn to the extent that the groove begin to disappear , the plates must be replaced.

Interplates : The interplates can generally be refitted, but should be replaced either when badly scored or worn more than 0.005 inch (0.13 mm) per face. The interplates should also be replaced when the friction plates are renewed.

Check all plates for signs of severe overheating or distortion.

Note: *Never attempt to reclaim friction plates or interplate by lapping or grinding.*

Actuator Plates: The actuator plates do not normally need replacing, but should be checked for severe scoring.

Thoroughly clean out the brake housing and remove any burrs or pieces of old gasket from the actuator and axle housings.

Reassembly

12. Reverse procedures 1 to 8 or 1 to 11 depending on the extent of disassembly, except:

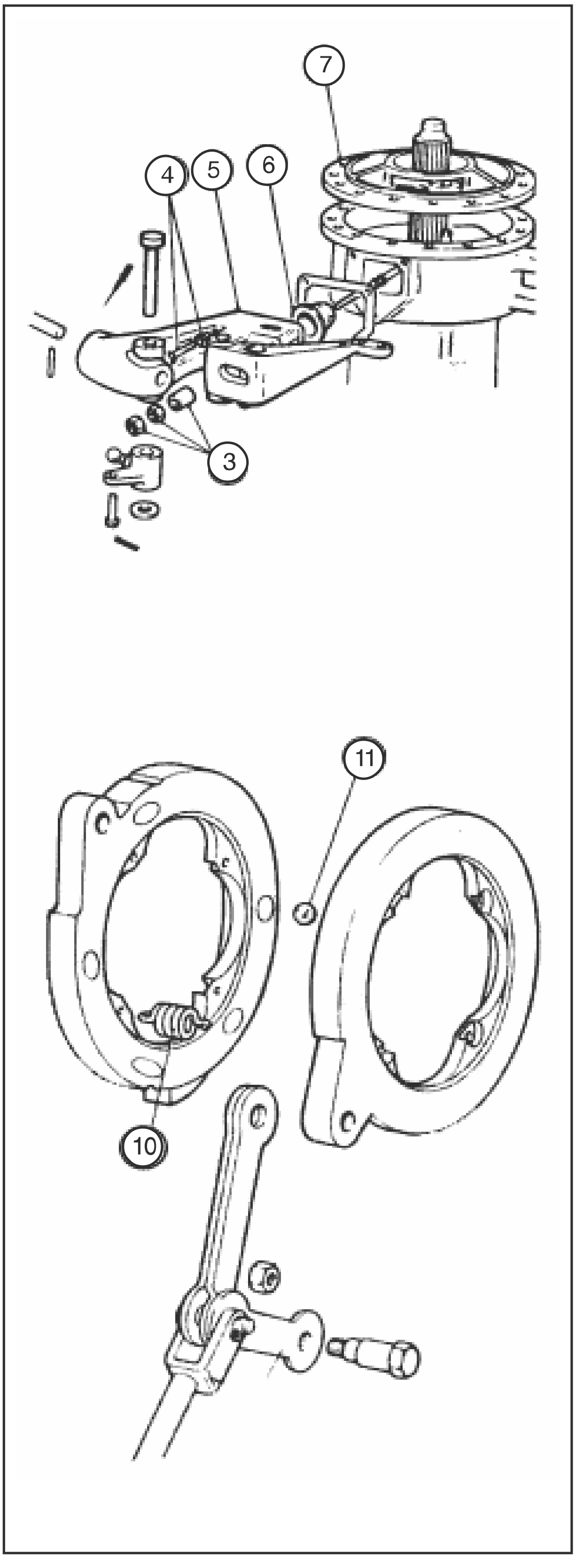


Fig 24

a. **Dip each friction plate, interplate and the actuator unit in clean transmission oil before refitting them into the housing. THIS IS MOST IMPORTANT. Refit all plates in the order in which they were originally assembled.**

b. Refit the carrier plate.

c. Fit a new rubber boot, preferably using Special Tool No. SER/164.

d. Smear the actuator rod with petroleum jelly, then refit the actuator housing ensuring that the lip of the rubber boot seats correctly in the ridge on the actuator rod. Do not displace the garter spring.

e. The three bolts are of varying lengths according to their location in the actuator housing.

13. Adjust and balance the brakes.

10B.16 RIGHT HAND BRAKE

Servicing

Special Tools: SER / 054 Tractor splitting stand

Disassembly

1. Remove the right-hand axle housing. (see operation 10B.8)
2. Manoeuvre the axle housing assembly off the jack and stand it on end.
3. Remove the brake adjusting locknut, nut and spacer.
4. Remove the three bolts and spring washers.
5. Remove the actuator housing complete with the differential lock lever mechanism.
6. Tap out and discard the rubber boot.
7. Remove the carrier plate.
8. Remove the brake components, turning each plate over and stacking in reverse order to ensure correct refitment.
9. If necessary, remove the brake stop rod from the housing.

   Only if necessary dismantle the actuator unit as follows:
10. Release the four springs.
11. Remove the actuator rod and links and the ball bearings.

Examination

Friction Plates : These have a minimum grooves depth of 0.12 inch (0.3 mm) when new. When worn to the extent that the grooves begin to disappear, the plates must be replaced.

Interplates : The interplates can generally be refitted, but should be replaced either when badly scored or worn more than 0.005 inch (0.13 mm) per face. The interplates should also be replaced when the friction plates are renewed.

Check all plates for signs of severe overheating or distortion.

Note: *Never attempt to reclaim friction plates or interplates by lapping or grinding.*

Actuator Plates: The actuator plates do not normally need replacement, but should be checked for severe scoring.

Thoroughly clean out the brake housing and remove any burrs or pieces of old gasket from the actuator and trumpet housing.

12. Reverse the procedure for reassembly

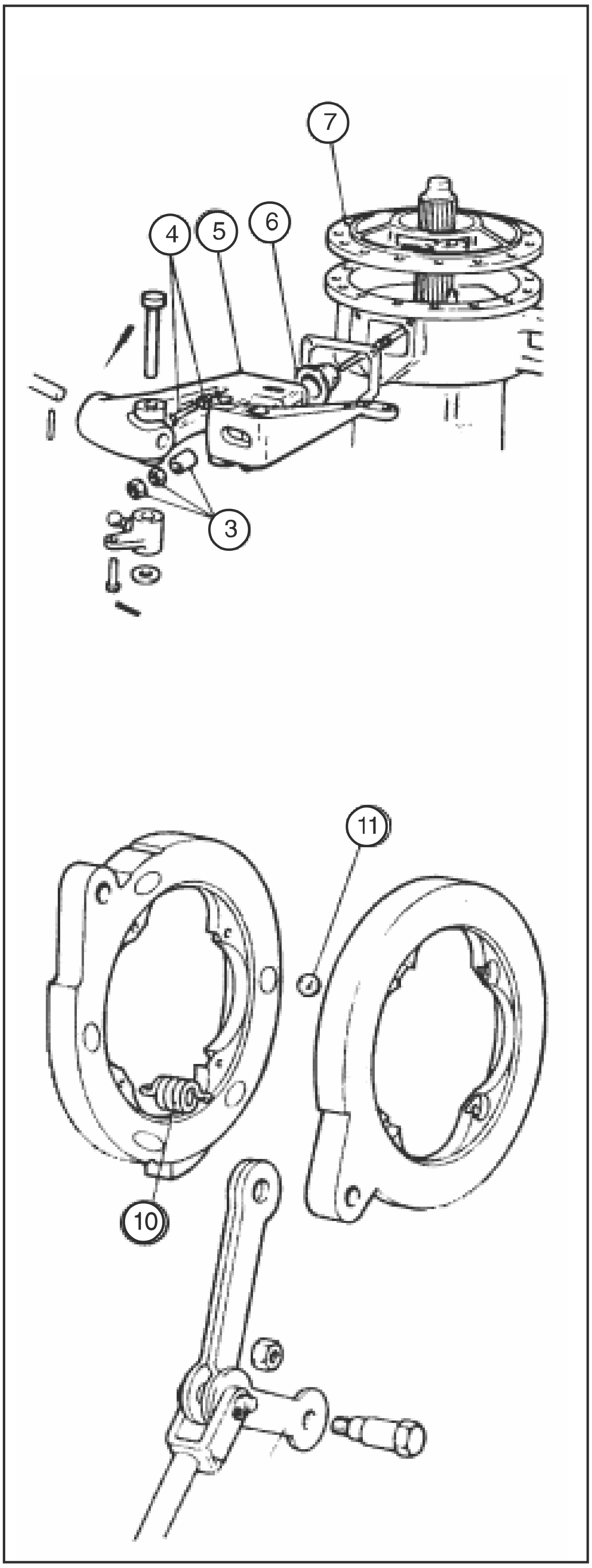


Fig 25

10B.17 DIFFERENTIAL LOCK ACTUATOR MECHANISM

Removal and Refitment

Removal

1. Remove the right-hand axle housing. (see operation 10B.8)
2. Manoeuvre the axle housing assembly off the jack and stand it on end.
3. Lift up the rubber seal
4. Release the locknut.
5. Rotate the differential lock operating lever out of engagement with the actuator fork.
6. Unscrew the fork from the shaft complete with its locknut and rubber seal.
7. Remove the carrier plate. (see operation 10B.11)
8. Remove the shaft, complete with the spring, washer, circlip and ‘O’ ring.

Examination

Examine the shaft for signs of wear or scoring. Clean and degrease the threads in the end of the shaft, and on the actuator fork.

Refitment

9. Fit a new ‘O’ ring to the shaft. If renewing the shaft, a new washer and circlip should be fitted.
10. Refit the shaft taking care not to damage the ‘O’ ring.
11. Refit the spring.
12. Refit the carrier plate. (see operation 10B.11)
13. Smear the threads of the actuator fork with loctite 241, then screw the fork fully into the shaft.
14. Unscrew the actuator fork until it will engage the differential lock operating lever in the horizontal position.
15. Tighten the locknut.
16. Push the rubber seal into position.

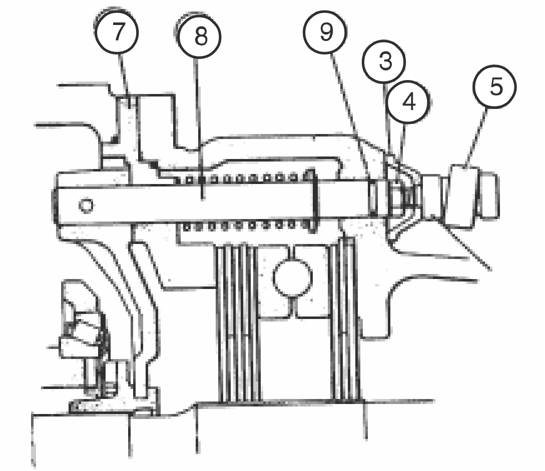


Fig 26

DIFFERENTIAL LOCK

Adjustment

1. Ensure that the pedal operates freely throughout its complete travel.
2. With the differential lock disengaged, the measurement between the inner flange of the actuator rod and the side of the diff casting should be 1.25 inch (31mm). This should give a measurement of 0.25-0.5 inch (6.35-12.7 mm) between the bottom of the foot pedal and the footstep.
3. If this is incorrect lift back the rubber seal covering the actuator fork locknut. Slacken the locknut then rotate the fork to obtain the measurement given.
4. Apply loctite 241 to the threads of the fork and then tighten the locknut.
5. Refit the rubber seal.

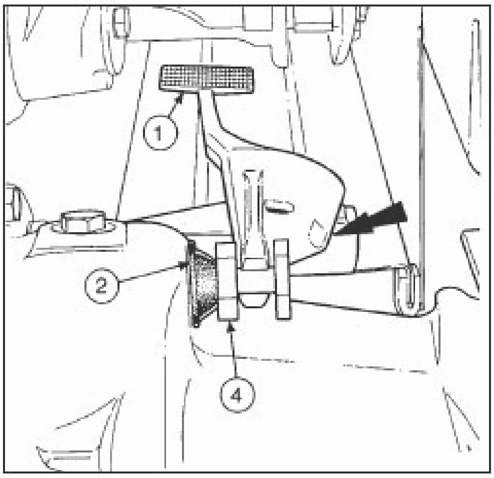


Fig 27

10B.18 DIFFERENTIAL LOCK COUPLER CAP

Removal and Replacement

Special tools : SER/029 Universal Pulley
SER/028 Puller Adaptor
SER/163 Bearing Driver

Removal

1. Remove the right-hand axle housing. (see operation 10B.8)
2. Remove the bearing cone using puller SER/028 and SER/029.

Note : *For clarity, the illustration shows the Differential removed. However for the actual operation this is not necessary.*

3. Remove the eight bolts.
4. Raise off the cap taking care not to Dislodge the case which would allow the differential gears to fall out.

Replacement

5. Fit the new coupler cap.
6. Insert and hand tighten the eight bolts.
7. Tighten the bolts progressively, and evenly to a torque of 80 lbf ft (108 Nm)
8. Refit the bearing cone using SER/163.
9. Refit the axle housing.

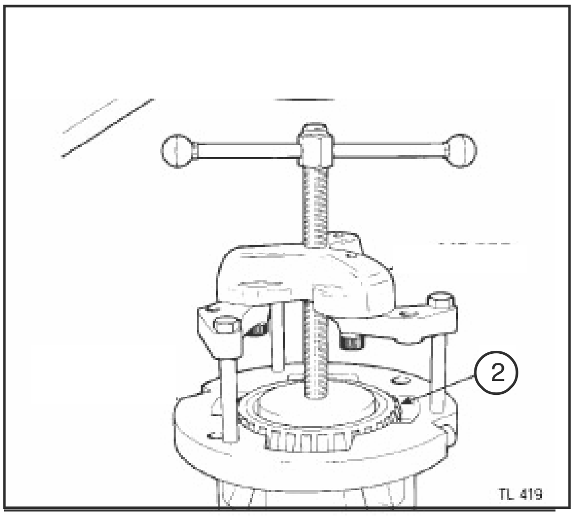


Fig 28

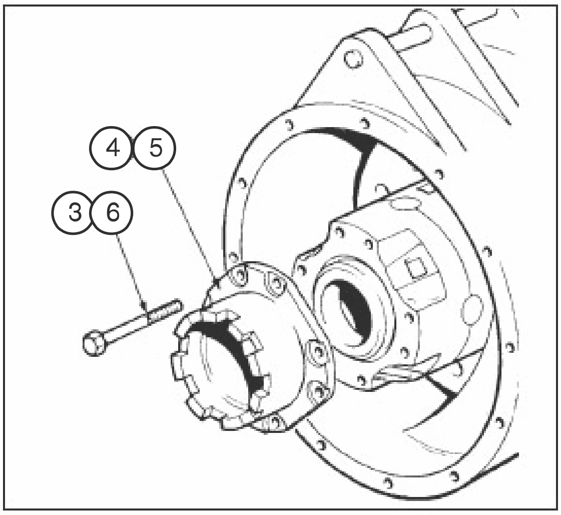


Fig 29

10B.19 DIFFERENTIAL LOCK

Pre-load Checking and Adjustment

Tool	: **Differential Bearing (Diff lock mechanism) Preload Gauge**
Tool No.	: **SER/023**
Purpose	: Preload check for differential side bearing. (Diff lock mechanism)
Application	: Oil immersed brakes

Tool	: **Straight Edge used in conjunction with SER/023.**
Tool No.	: **SER/024**
Purpose	: To determine the shim size for preloading.
Application	: Oil immersed brakes

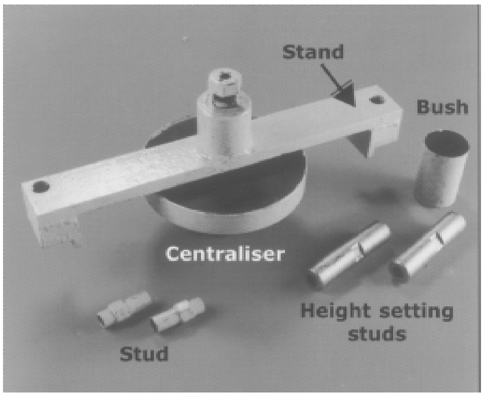


Fig 30

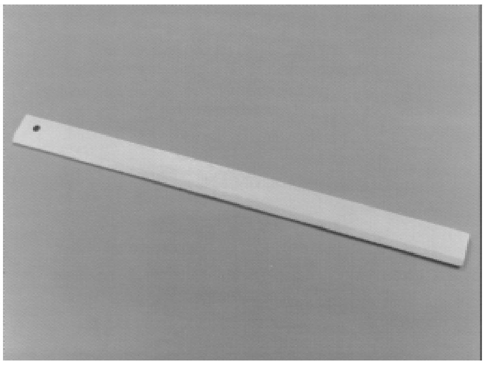


Fig 31

Procedure :

1. Remove the right-hand axle housing.
2. Insert the bush of the tool inside the Differential Case.

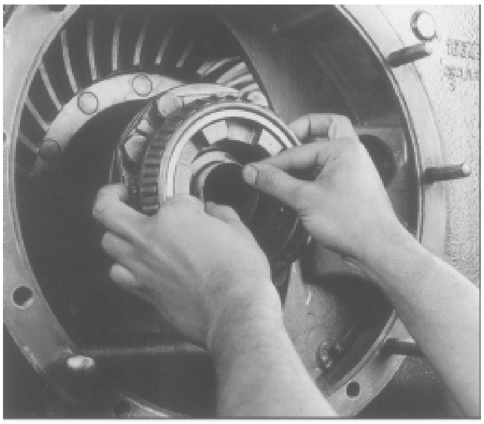


Fig 32

3. Insert the Centralizer of the tool with Bearing cup.

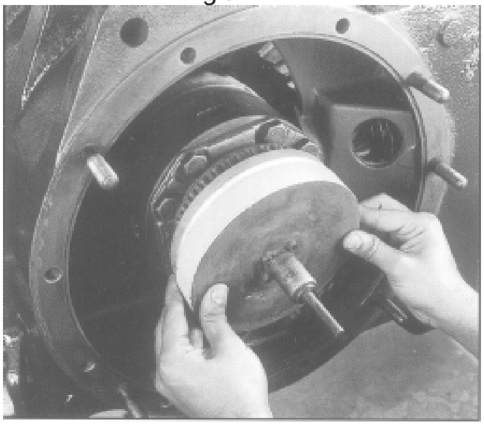


Fig 33

4. Position the tool stand with the help of 2 studs and tighten the centre nut to a torque of 18 lbf.ft (25 Nm).

Precautions :

1. Ensure proper seating of tool stand on Centre Housing.
2. Do not over tighten the centre nut of the tool.

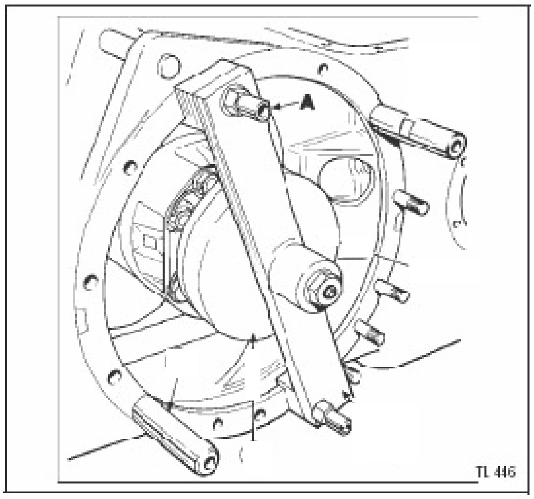


Fig 34

4. Fix the height setting studs diagonally opposite to tool stand, place the Straight Edge on it and measure the gap between the centre nut and Straight Edge using a Feeler Gauge. This gap determines the shim size. (see below)

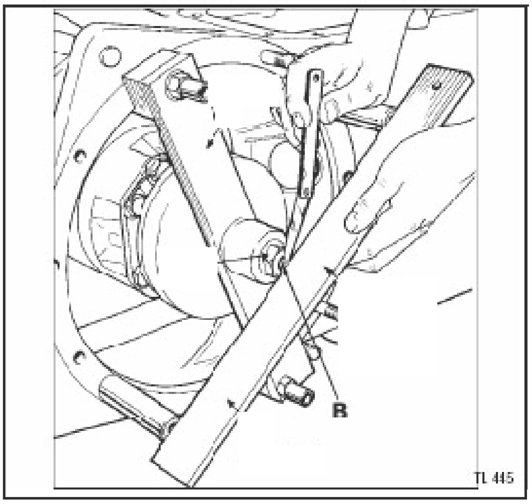


Fig 35

Table for shim selection

Feeler Gap (Equal Shield thickness) mm	inch	Means of Identification
0.45 - 0.53	0.019 - 0.021	Eight Dots
0.61 - 0.66	0.024 - 0.026	Seven Dots
0.74 - 0.79	0.029 - 0.031	No Dots
0.86 - 0.91	0.034 - 0.036	One Dot
0.99 - 1.04	0.039 - 0.041	Two Dots
1.12 - 1.17	0.044 - 0.046	Three Dots
1.25 - 1.30	0.049 - 0.051	Four Dots
1.37 - 1.42	0.054 - 0.056	Five Dots

After selecting the shim, remove the tool assembly from Centre Housing and the Bearing cup. Fit the selected shim behind the Bearing cup on Axle Housing right-hand. Assemble the Axle Housing right-hand in the usual manner.

10B.20 RIGHT HAND DIFFERENTIAL BEARING

Removal and Refitment

Special Tools : SER/028 Puller Main rod
SER/162 Bearing Driver
SER/163 Bearing Drive
SER/029 Adapter

Removal

1. Remove the right-hand axle housing. (see operation 10B.8)
2. Pull off the bearing cone using puller SER/028 and SER/029
3. Remove the carrier plate and drive out the bearing cup.

Replacement

4. Drive the new bearing cone to the differential lock coupler cap using SER/163 and SER/162.
5. Check the bearing pre-load.

10B.21 DIFFERENTIAL UNIT

Removal and Refitment

1. Remove the left-hand axle housing. (see operation 10B.7)
2. Manoeuvre the differential assembly out of the centre housing.

Warning: The differential unit is heavy and awkward to handle. Take care when removing and refitting it.

Refitment

3. Manoeuvre the differential unit into the centre housing, engaging the splines of the right-hand axle shaft.

Note: *If any of the differential component have been replaced, the Pre-load should be checked.*

4. Refit the left-hand axle housing. (see operation 10B.7)

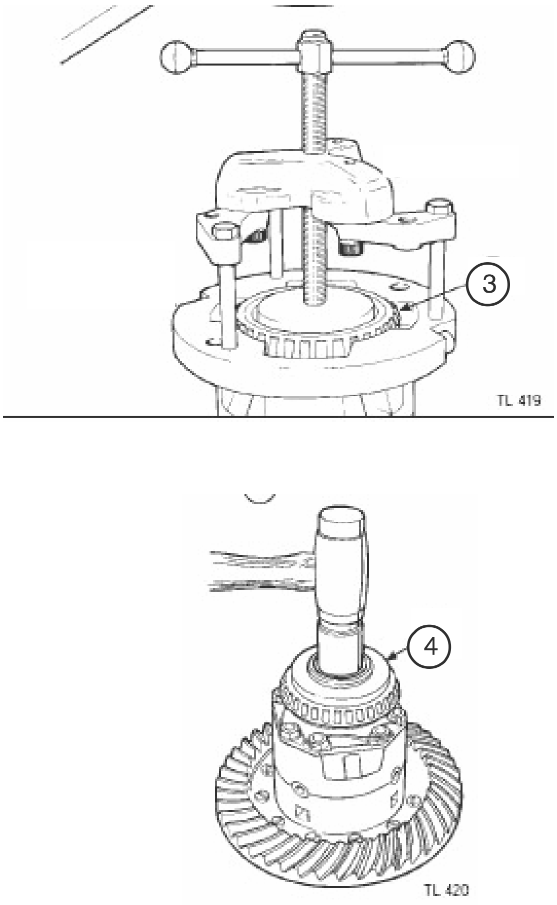


Fig 36

10B.22 DIFFERENTIAL LEFT HAND BEARING

Removal and Replacement

Special Tools :

SER/G/204	To press cup on diff. carrier (Left-hand)
SER/G/207	To press cone on differential lock.
SER/G/228	Plate diff. carrier cone removal
SER/G/227	Diff. case (Left-hand) cup removal

Removal

1. Remove the differential .
2. Remove the left-hand carrier plate.
3. Assemble SER/G/228, then pull Off the bearing cone.
4. Assemble SER/G/227 and pull out the bearing cup.

Replacement

5. Assemble SER/G/204 with a new bearing cup.
6. Pull the new cup into the differential unit.
7. Fit the new bearing cone ,

   Then drive it fully onto the carrier plate using

   A hammer and SER/G/207.
8. Refit and differential unit.
9. Check the differential pre-load.

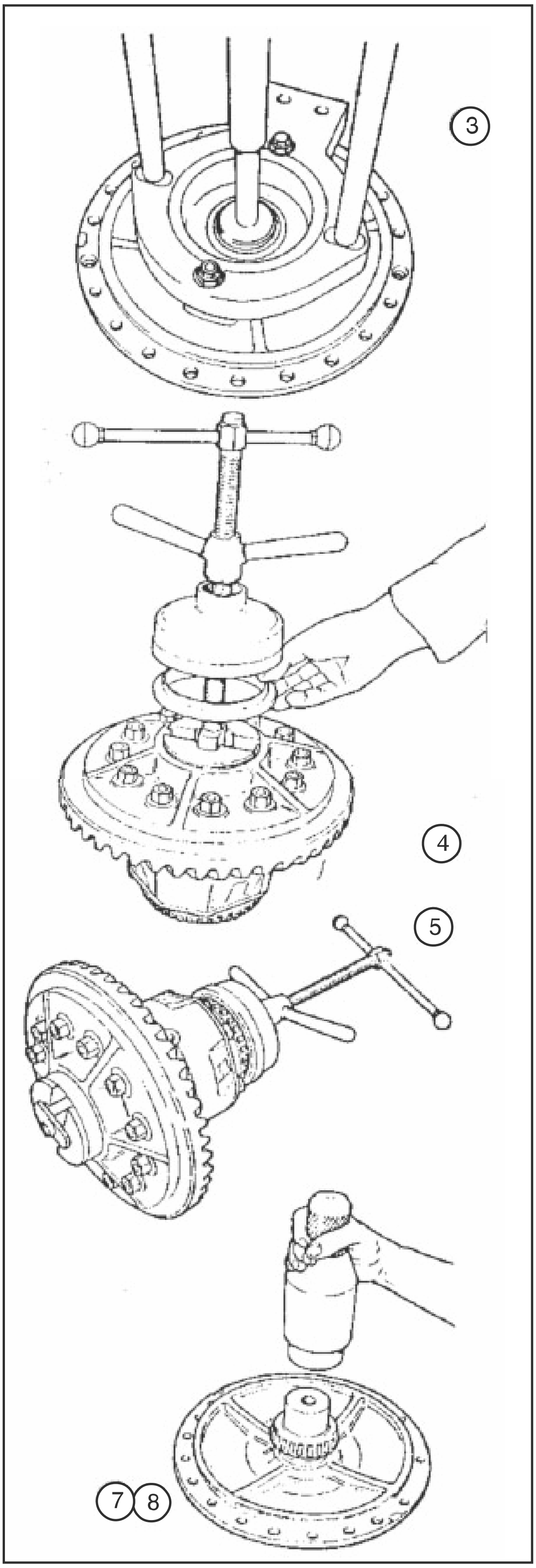


Fig 37

10B.23 DIFFERENTIAL UNIT

Servicing

Special Tools :

SER/017	Holder
SER/018	Bench Adaptor
SER/028	Universal Puller
SER/029	Adaptor
SER/G/207	To press cone on diff. lock

Disassembly

1. Remove the differential unit. (see operation 10B.21)
2. Fit SER/018 to the bench.
3. Fit SER/017 to SER/018.
4. Place the differential on SER/018.
5. Remove the bearing cone using puller SER/028 and SER/029.
6. Remove the eight bolts.
7. Remove the coupler cap and right-hand case.
8. Remove the cross joint and pinions assembly with the thrust washers.
9. Remove the differential gears and their thrust washers.

Examination

Examine all of the differential components and replace any that are worn or damaged.

> ***Note:*** *If any of the spider gears are worn, a full set of four new gears should be fitted. In such circumstances, differential gears may also need to be replaced.*

Reassembly

Reverse procedures 2 to 9 except:

a. Refit the right-hand differential case with the marking aligned.
b. Tighten the eight bolts to a torque of 108 Nm (80 lbf ft).
c. Refit the bearing cone using SER/G/207.

10. Refit the differential unit.

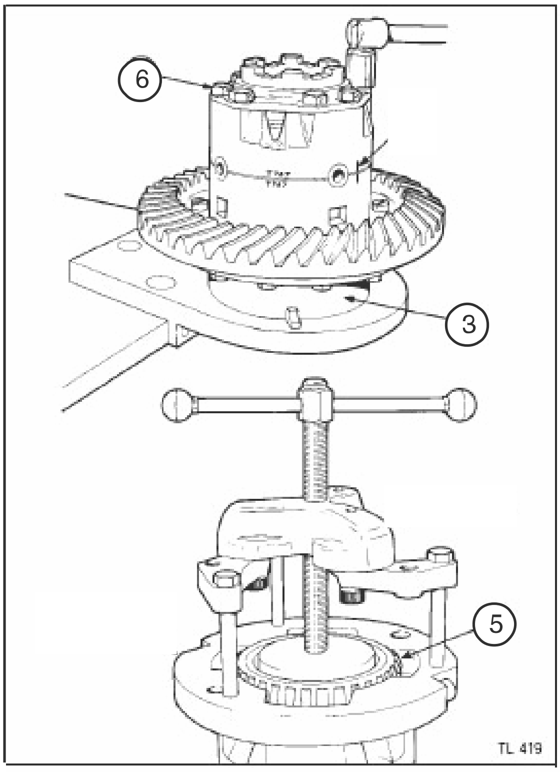


Fig 38

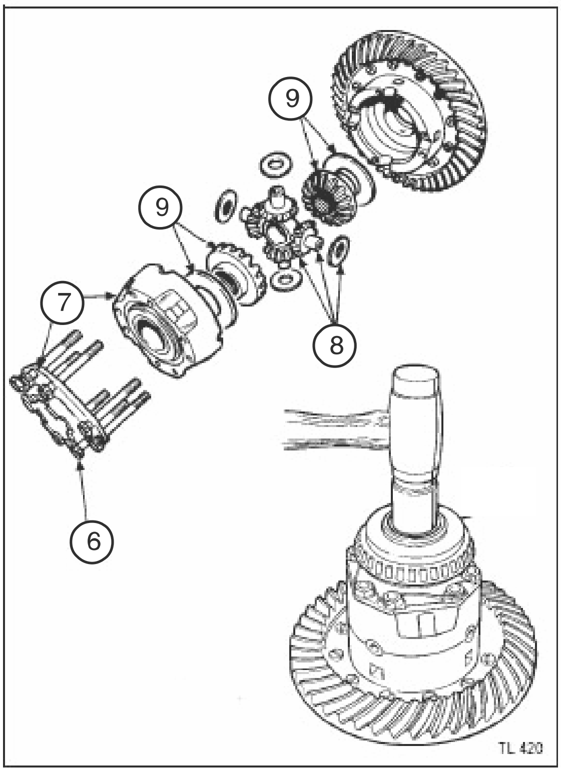


Fig 39

10B.24 CROWN WHEEL

Removal and Replacement

Special tools :

SER/017	Holder
SER/018	Adaptor

Removal

1. Remove the differential gears. (see operation 10B.23)
2. Place the differential unit on a bench with the teeth facing downwards.
3. Centre punch each of the rivet heads, centrally.
4. Using a 13 mm (1/2 in) drill, drill out each of the rivet heads until they become detached from their shanks.
5. Drive out the rivets.
6. Drive off the crown wheel.

   Note: *When fitting a new Crown wheel, the pinion must also be replaced.*

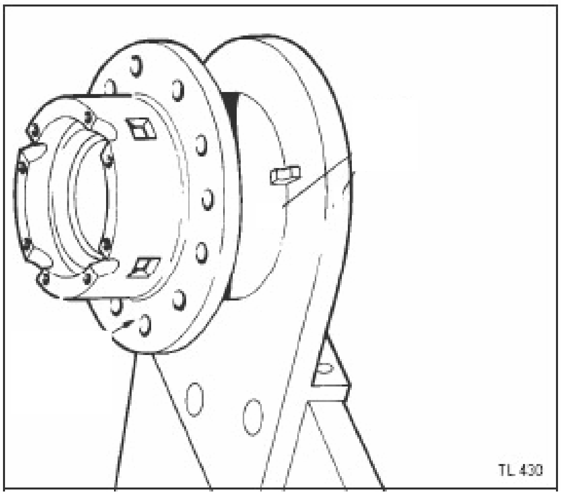


Fig 40

Replacement

7. Ensure that the mating faces of the differential case and the new crownwheel are perfectly flat.
8. Fit SER/017 and SER/018 to the bench.
9. Fit the left-hand differential case, with the mating face upwards.
10. Degrease the crownwheel, left-hand differential case, differential bolts and nuts with brake cleaner.
11. Collect together all items necessary for speedy assembly.

These items are :

A torque wrench, the correct size socket and apply Loctite to the threads.

12. Open the epoxy resin kit 1852913M91. Its contents are:
    One jar containing 10 ml of resin. (This jar is also used as a mixing vessel).
    One jar containing 5 ml of hardener.
    One glass stirring rod.
    One bush.
13. Pour the hardener into the resin jar and mix thoroughly using the glass rod.
14. Apply an even coating of adhesive to both mating surfaces.

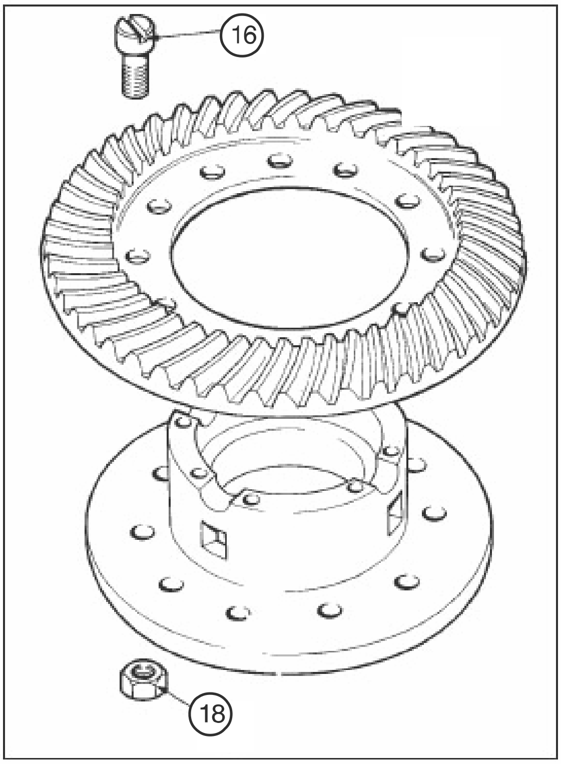


Fig 41

15. Fit the crownwheel to the differential case.

    Note: *These two components are in interference fit and must, therefore, have their bolt holes aligned accurately before being fitted together.*

16. Fit the twelve bolts with their heads nearest the crownwheel teeth.
17. Apply two drops of Loctite to the first thread of each bolt.
18. Fit the nuts, and tighten them progressively and evenly to a torque of 118 lbf. ft (160 Nm).
19. Refit the differential components. (see operation 10B.21).

    Note: *Operations 14 to 18 must be completed within 30 minutes of mixing the resin and harder.*

20. Cure the resin bonding by subjecting the differential assembly to uniform heating as follows:-
    a. 120 degree centrigrades (248°F) for a minimum of 1 hour
    b. or 40 degree centrigrade (105 F) for a minimum of 12 hours
    c. or 30 degree centrigrade (86°F) for a minimum of 16 hours
    d. or 20 degree centrigrade (68°F) for a minimum of 24 hour
21. Refit the differential unit. (see operation 10B.20)

10B.25 PINION ASSEMBLY

Servicing

Special Tools :	SER/038	Hand Press
	SER/059	Adaptor
	SER/056	Adaptor
	SER/061	Pre-load Gauge
	SER/060	Pinion lock nut 'C' Spanner.
	SER/064	Preload checking aid

Disassembly

1. Remove the pinion assembly.
2. Remove the locking ring as follows.

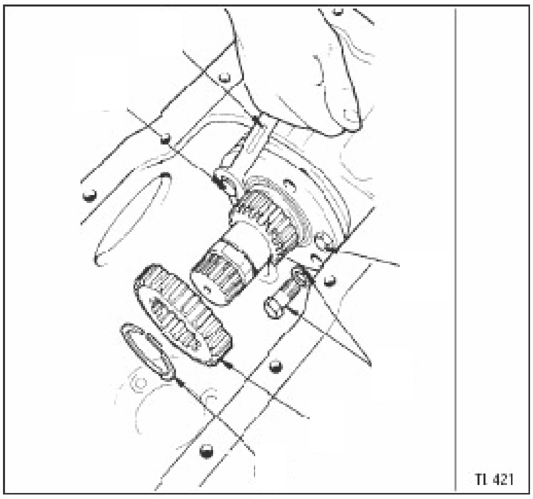


Fig 42

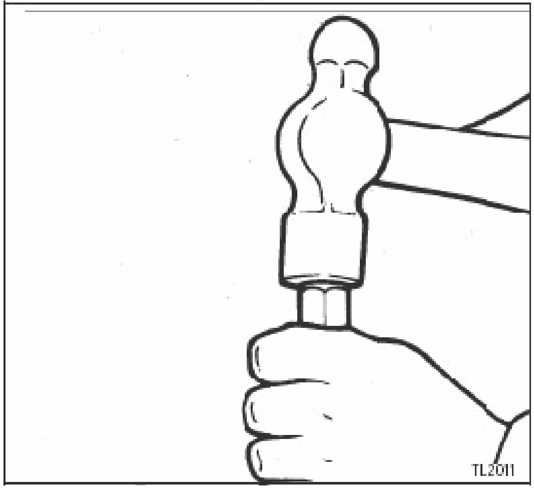


Fig 43

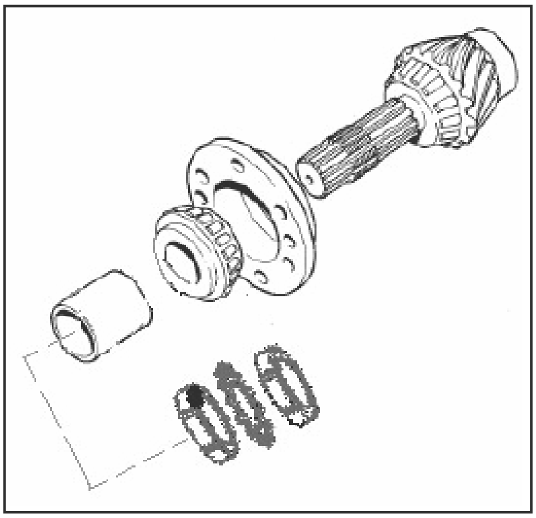


Fig 44

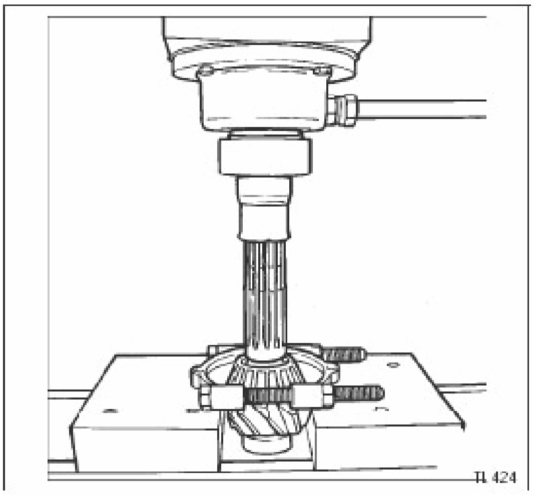


Fig 45

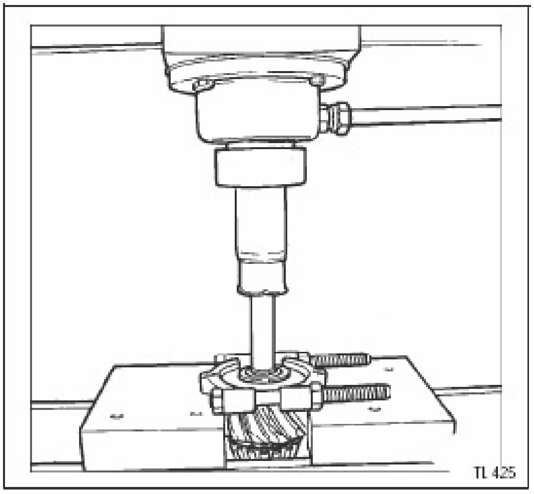


Fig 46

   a. Place the pinion in a soft faced vice with the jaws of the vice holding the flats, adjacent to the collar locking rollers.
   b. Release the tab washer from the lock nut.
   c. Remove the lock nut by using SER / 060 and SER / 064.
   d. Remove the tab washer and locknut

   Note: *Great care should be taken to avoid damaging the threads of the pinion.*

3. Remove the oil slinger.
4. Remove the housing, complete with the front bearing cone.
5. Fit the pinion to SER/038 with SER/059 and SER/056. Press off the bearing.
6. Remove the snap ring securing the pilot bearing to the pinion.
7. Fit the pinion to SER/038 using adaptor SER/059 then press off the pilot bearing.

Examination

Examine all components for signs of wear, scoring or pitting. Any faulty or worn parts must be replaced.

Note:

a. If the pinion is damaged the crown wheel must also be replaced as these are only supplied in matched sets.

b. The taper roller bearings are serviced as a pair, assembled with the housing.

c. New snap rings should always be fitted.

Reassembly

8. Using SER/038 and SER/059, press the pilot bearing on the pinion.
9. Secure the pilot bearing with a new snap ring.
10. Using SER/038 and SER/059 and SER/056 press the bearing onto the pinion.
11. Locate the pinion in its housing and fit the front bearing cone.
12. Refit the oil slinger and a new locking ring, hand tightened.
13. Hold the housing in a soft faced vice.
14. Fit a SER/061 pre-load gauge to the pinion and tighten the locking ring to give a pre-load reading of 18 - 22 lbs.inch (2 - 2.5 Nm).
15. Remove the gauge, tap the pinion firmly to centralize the bearings, then re-check the pre-load.

16. Secure the locking ring by tapping a locking roller down either side of one of the pinion splines.

Note: The needle rollers must be driven flush with the locking collar.

Before refitment, the pinion assembly should be freely lubricated with clean transmission oil.

17. Refit the pinion assembly.

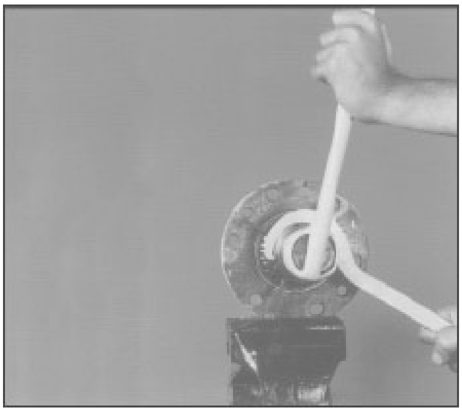


Fig 47

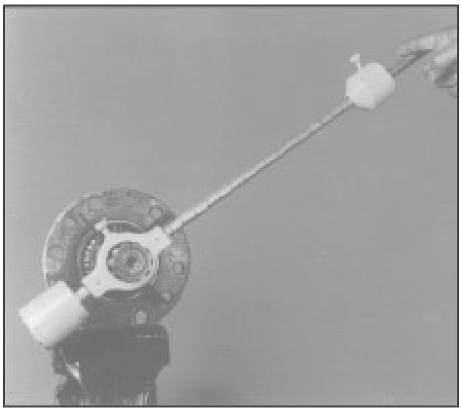


Fig 48

10B.26 REAR DRIVE SHAFT

Servicing

Special tools: SER/022 Needle Roller Bearing Puller
SER/063 Needle Roller Bearing Driver
SER/058 Universal Handle

Disassembly

1. Remove the lift cover.
2. Remove the split pin from the shear tube.
3. Remove the shear tube.
4. Remove the rear drive shaft.
5. Locate the end of SER/022 underneath the bearing cage.
6. Extract the bearing.
7. Remove the plunger and spring.

   Examine the drive shaft for signs of wear and fit a new needle roller bearing.

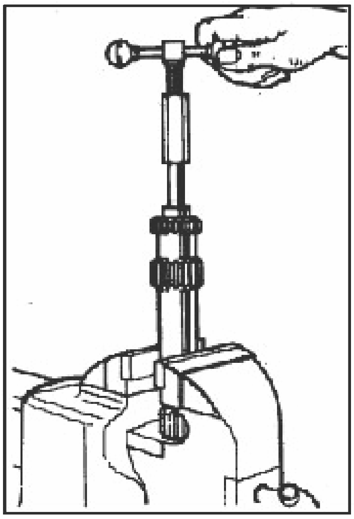


Fig 49

Reassembly

Reverse procedures 1 to 7 except:

a. Place the bearing depth control collar (SER/063) on the end of the driveshaft over the new bearing. Drive the bearing into the drive shaft using SER/063 and the SER/058 universal handle until the tool contacts the depth control collar.

b. Fit a new split pin to give an end float of 0.015 to 0.100 inch (0.40 to 2.50 mm).

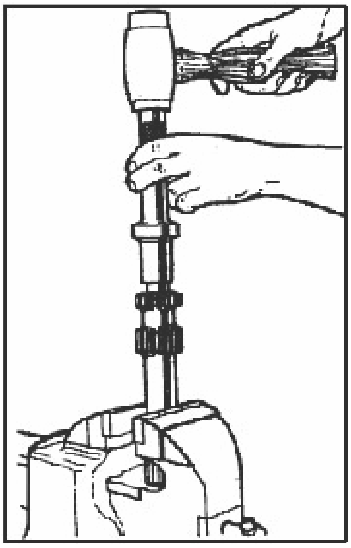


Fig 50

10B.27 PARKING BRAKE SERVICING

Removal and refitment:

Removal:

1. Disconnect the two parking brake cables from the brake actuators and at the anchor points on the side cover.
2. Remove the two bolts securing the parking brake assembly to the frame of the tractor.
3. Withdraw the parking brake assembly and the two cables.
4. Remove the cables if necessary.

Refitment:

5. Reverse the procedure 1 to 4 except.

   a. Route the right hand cable over the transmission case ensure that it has no sharp bends.

   b. Check the brake operates freely.

6. Adjust and balance the brakes (see the operation 10B.14).

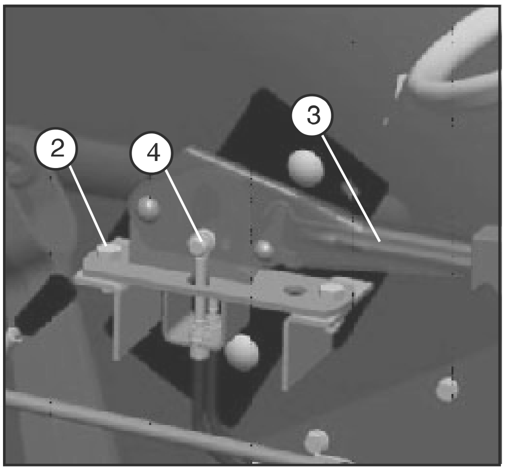


Fig 51

SECTION 10 C

Brakes

Drum-Brakes

Table of Contents

Operation No.	Description		Page No.
10C.1	Specification	…	10C - 4
10C.2	General Description	…	10C - 5
10C.3	Drum Brake – Adjustment	…	10C - 6
10C.4	Drum Brake – Removal	…	10C - 6
10C.5	Drum Brake – Overhaul	…	10C - 8

10C.1 SPECIFICATION

Diameter	:	14 inch (355.6 mm).
Width	:	2 inch (50.8 mm).
Operation	:	Rods and levers
Parking brake	:	Rod operated on both brakes independent of the foot brake (Pendant pedal)
Brake pedal free travel	:	1 inch (25 mm).
Brake shoe concavity maximum	:	0.004 inch (0.1 mm).

Bolt torques

Brake shoe anchor pins	:	148 lbf. ft.(200 Nm).
Rear wheel nuts	:	200 lbf.ft.(271 Nm).

10C.2 GENERAL SPECIFICATIONS

General description double action drum brakes

The following general description applies to tractors fitted with double acting, floating cam type, drum brakes which operate on the rear wheels only. They are internally expanding 14 X 2 inch (355.6 X 50.8 mm) Drum Brakes. The shoes are drilled to receive riveted linings in service

Each brake consists of a back plate on which is mounted the double anchor pin assembly securing one end of each shoe. The other end of each shoe fits into slots in the adjuster assy., and is held in position by a spring.

Between the shoe webs at the anchor pin end is the operating cam shaft which is connected by a linkage to the pedal. A shoe to anchor the pin spring is connected between the anchor pin and shoe web of each shoe. The shoes are kept square in relation to the back plate by steady post and the shoe hold down pins. The back plate is secured to the rear axle housing and is enclosed within a drum which is fitted to the rear axle shaft assy.

General Description

The brake on the tractor is operated by two independently operated Pendant pedals located on the right hand side.To assist turning the right pedal operates the right hand brake and the left pedal operates the left hand brake,. For highway use, the brakes must be used together by operating an interlocking latch which joints the two pedals. A parking brake is provided which operates both brakes together independent of the foot brakes mechanically through a rod control.

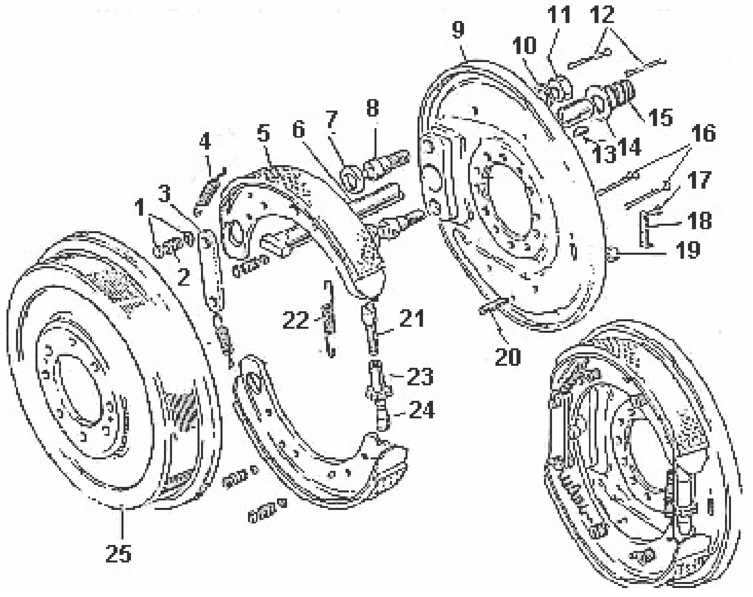


Fig 1

1&2.	Brake Securing Spring and Caps
3.	Anchor Pin Plate
4.	Spring shoe to anchor pin plate
5.	Brake shoe
6.	Actuating cam
7.	Anchor pin plate spacer
8.	Anchor pin
9.	Back plate
10 & 11.	Anchor pin spring washer and nut
12 &16.	Pin brake securing spring
13.	Woodruff Key
14.	Cam washer and spring
15.	Spring cam shaft
17.	Cover plate Pivot
18.	Cover plate
19.	Steady Post nut
20.	Steady Post
21.	Adjuster
22.	Spring Adjuster
23.	Adjuster Tappet
24.	Pivot Adjuster
25.	Brake drum

10C.3 DRUM BRAKE

Adjustment :

Procedure

1. Chock the front wheels and jack the tractor rear wheels clear of the ground, release the parking brake
2. Slacken the parking brake adjuster.
3. Unlatch the brake pedals.
4. Move back the cover plate (Item 1 in Fig. 2) on the brake back plate.
5. Insert a screw driver thro' the slot in the back plate and lever the adjuster towards the front of the tractor until the wheel is locked. (Item 1 in Fig. 3)
6. Slacken the adjuster until the wheels rotates freely.
7. Repeat procedures 4 to 6 for the other wheel brake.
8. Readjust the parking brake adjuster so that the parking brake is effective at approximately the third click.
9. Latch the two brake pedals together.
10. Road test the tractor, slacken the adjuster on the side to which the tractor pulls.

10C.4 DRUM-BRAKE REMOVAL

Removal and Refitment :

Removal :

1. Jack up the tractor
2. Remove the rear wheel.

3,. Slacken off the brake adjustment. (Item 23 in Fig. 4).

4. Remove the brake drum (Item 25 in Fig. 4)
5. Release the brake rods from the brake cam shaft lever.
6. Remove the shoe hold down spring assys. Grip the pin with a pair of pliers.(Item 1, 2 & 12 in Fig. 4)

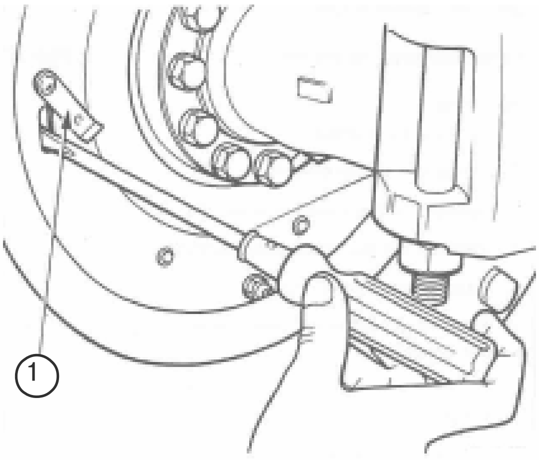


Fig. 2

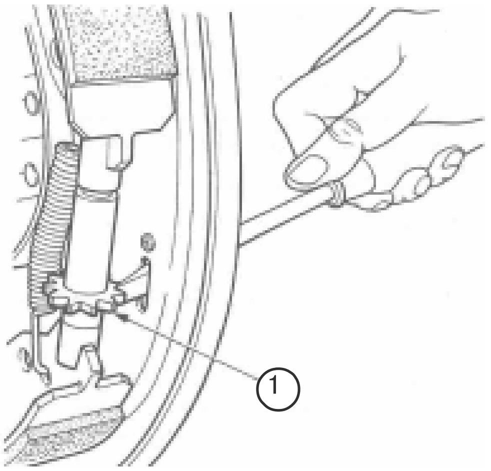


Fig. 3

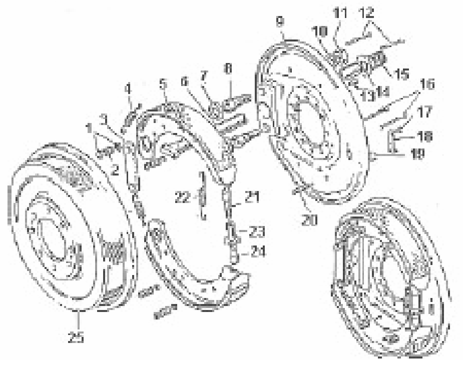


Fig. 4

7. Simultaneously press and turn the Dished washer until released, then remove the two washers and the spring. (Item 1 & 2 in Fig. 4). Repeat this procedure for the 4 sets of fixings
8. Force apart the brake shoes (Item 5 in Fig. 4) at the adjuster end to allow the adjuster to drop out of position.
9. Remove the spring. (Item 22 in Fig. 4).
10. Remove the two springs by levering with a screw driver between the springs and the anchor plate. (Item 4 in Fig. 4).
11. Remove the anchor plate. (Item 3 in Fig. 4).
12. Lift off the two brake shoes. (Item 5 in Fig. 4).
13. Remove the two spacer washers. (Item 7 in Fig. 4).
14. Clean of all parts. Ensure that the adjuster threads are free to rotate.

Refitment

1. Lightly smear both ends of the new brake shoes and the flat end of the cam shaft with white brake grease.
2. For refitment follow the reverse procedures of removal and except
    (a) To facilitate refitment of the spring, use a length of wire, looped around the hook of the spring and pull the spring over the anchor pin.
    (b) Ensure that the adjuster is fitted with the star wheel adjacent to the adjusting hole in the back plate.
3. Slacken the steady post nuts. (Item 19 in Fig. 4).
4. Screw the steady post well into the back plate. (Item 20 in Fig. 4).
5. Turn the adjuster to the fully off position. (Item 23 in Fig. 4).
6. Refit the brake drum. (Item 25 in Fig. 4).
7. Slacken the anchor pin nuts. (Item 11 in Fig. 4).
8. Using the adjuster, expand the brake shoes, then tap the anchor pin nuts to ensure that the shoes are seating correctly.
9. Repeat this procedure until the adjuster can not be tightened any further.
10. Coat the threads of the anchor pins with grease and tighten to a torque of 148 lbf.ft (200 Nm) .
11. Slacken off the adjuster and remove the brake drum.
12. Screw in the steady posts until they touch the brake shoe webs. Then secure the post with nuts.
13. Re fit the brake drum.
14. Reconnect the brake rods.
15. Refit the rear wheel and tighten the nuts progressively and evenly to a torque of 200 lbf.ft. (271 Nm).
16. Adjust and balance the brakes.

    NOTE : *Sponginess and lack of braking power even after adjusting brakes may indicate that brake lining are excessively or unevenly worn or perhaps contaminated by oil or grease. Brakes squeal may indicate that the linings are unevenly worn or the rivet heads are protruding above the lining face. The brake shoes and lining should be examined when these symptoms become evident and should be changed. If the lining is worn to less than 1/3 of its original thickness at any one point (less than 3/32 inch – 2.38 mm). Or if the rivet heads are less than 1/10 inch – 1.5 mm below the lining face. Different lining materials must not be used as it will be found difficult to achieve satisfactory braking power or balance.*

10C.5 DRUM BRAKE

Overhaul

Disassembly

1. Remove the brake.
2. Remove the axle shaft and brake assy.
3. Unscrew the screw in the cam shaft lever
4. Remove the cam shaft lever and woodruff key (Item 3 in Fig. 7).
5. Slide the washer and conical spring off the cam shaft. (Item 5 in Fig. 7).
6. Remove the cam shaft. (Item 1 in Fig. 7).
7. Remove the anchor pins, spring washers and nuts. (Item 2 & 4 in Fig. 7).
8. Remove the steady post and nut(Item 6 in Fig. 7).

   Examination : Clean and inspect all components, any showing signs of excessive wear or damage must be replaced. Ensure that all threads are cleaned and free to turn, coat with white brake grease.

Reassembly

1. For re-assembly follow the reverse procedures of dis-assembly except
   (a) Refit the washer first, then the conical spring (large diameter towards the back plate). Half compress the spring to load the cam shaft.
   (b) Position the brake lever on the cam shaft with 0.236 inch (6 mm) clearance from the axle housing. Tighten the screw.
   (c) Refit the anchor pins, spring washers and nuts but do not tighten until resetting the brakes.
   (d) Refit the steady post and nuts but do not adjust and tighten until the brakes are set.
2. Adjust and balance the brakes.

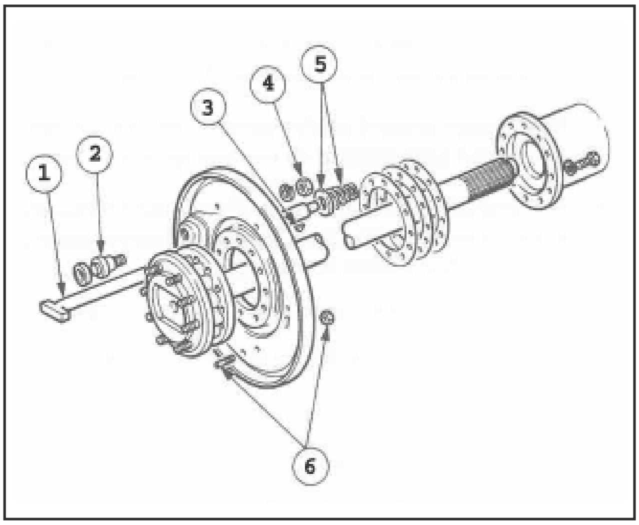


Fig. 7

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SECTION 11

Part A

Lift Hydraulics

Section 11 - Part A

Lift Hydraulics

Table of Contents

Operation No.	Description		Page No.
11A . 1	Specification	...	11A– 3
11A . 2	General description	...	11A– 4
11A . 3	Control spring assembly - removal	...	11A–10
11A . 4	Control spring assembly - overhaul	...	11A–10
11A . 5	Hydraulic lift cover - removal	...	11A–11
11A . 6	Hydraulic lift cover - overhaul	...	11A–12
11A . 7	Hydraulic lift cylinder - overhaul	...	11A - 15
11A . 8	Quadrant and support assembly - overhaul	...	11A - 16
11A . 9	Hydraulic static adjustments - adjust	...	11A - 17
11A . 10	Hydraulic external adjustments - adjust	...	11A - 19
11A . 11	Hydraulic pressure test - check	...	11A - 21
11A . 12	Hydraulic lift pump - removal	...	11A - 22
11A . 13	Hydraulic lift pump - overhaul	...	11A - 23
11A . 14	Hydraulic relief valve - removal	...	11A - 35
11A . 15	Right-hand side cover - removal	...	11A - 36
11A . 16	Right-hand side cover - overhaul	...	11A - 36
11A . 17	Hydraulic pump oil strainer - servicing	...	11A - 37

11A . 1 SPECIFICATION:

Hydraulic pump:

Model	...	MK 3
Type	...	Four cylinder, scotch yoke, driven from the PTO drive line
Output Standard flow	...	4.7 gpm (17.8 lpm).

Pressure relief valve setting:

MF.2605/2615	...	190 - 225 kg/cm^2 (2702 - 3200 psi)
Functions	...	Draft control, Position control, Response control, and Constant pumping.

Lift cylinder size:

MF.2605/2615	...	3 1/8 inch (79.4 mm) diameter

Settings required:

Draft Control rod clearance	...	0.228 inch (5.8 mm).
Vertical lever load	...	1.3 kgf (2.86 lbf)
Vertical lever setting angle	...	90°
Response lever clearance	...	0.236 inch (6 mm).
Linkage loads for running adjustments	...	400 kgf (882 lbf) minimum.
Lift arm rotation Transport setting	...	0.236 inch (6 mm).

Special tools:

MF.148B	...	Pressure test gauge
MF.163	...	Spring retainer nut wrench
MF.226C	...	Lift cover remover/replacer
MF.272	...	Ram arm gauge
MF.333	...	Draft Control rod gauge
MF.349	...	Valve facing cutter and coining tool set
MF.350	...	Valve chamber circlip replacer
MF.351	...	Valve chamber plug remover
MF.352	...	Control valve spring retainer clip
MF.353	...	Control valve body ‘O’ ring guide
MF.354	...	Control valve body replacer
MF.356C	...	Position and Draft Control setting gauge
MF.420	...	Hydraulic ram piston seal replacer - 3.11 inch (79 mm)
MF.455	...	Pressure relief valve test capsule
MF.3001	...	Pressure test kit
MF 273A	...	Hydraulic control lever setting fixture.

Bolt torques:

Control spring screw	...	5 lbf.ft.(7 Nm)
Lift cover bolts	...	65 lbf.ft.(88 Nm)
Front ram cylinder nuts	...	162 lbf.ft.(220 Nm)
Rear ram cylinder nuts	...	225 lbf.ft.(305 Nm)
Pump body retaining nuts	...	29 lbf.ft. (40 Nm)
Vertical lever end plate bolts	...	15 lbf.ft. (20 Nm)
Pressure relief valve assembly	...	81 lbf.ft. (110 Nm)
Relief valve	...	18 lbf.ft. (25 Nm)
Transfer cap	...	32 lbf.ft. (44 Nm)

11A . 2 GENERAL DESCRIPTION

General: Fig 1

The Ferguson hydraulic system comprises a four cylinder scotch yoke type pump (1) which delivers oil, through a vertical pipe (2) to the cylinder (3).

A connecting rod from the cylinder piston engages in the ram arm which is splined on to the lift shaft which carries the linkage lift arms.

When oil, under pressure from the pump, is delivered to the ram cylinder (3), the piston is forced rearwards and pushes the ram arm upwards, causing the lift shaft to rotate and raise the lift arms.

Conversely, when the oil is allowed out of the cylinder, the piston moves back under the load of the lift arms.

The hydraulic pump is driven by the PTO drive from the main clutch, via the gearbox constant mesh gears and the PTO drive shaft. It is therefore rotating whenever the forward part of the PTO system is being driven.

Oil flow from the pump is controlled by an integral control valve on the suction side of the pump.

The pump control valve is moved by the quadrant levers, forces down the top link, or the cam on the cross shaft.

The speed of movement of the valve into discharge (lower) is controlled by the Response unit.

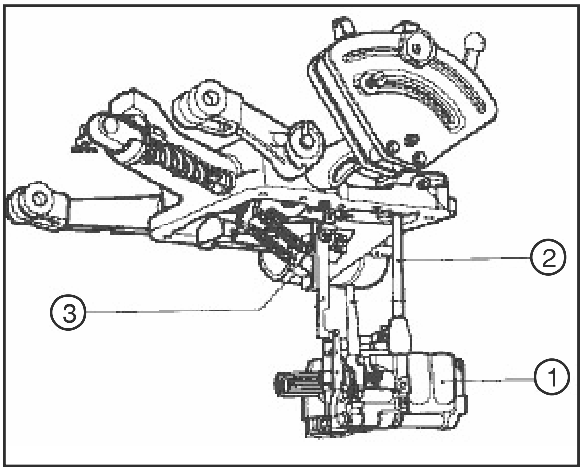


Fig 1

Hydraulic linkage pump (Fig. 2) .

The pump consists of two piston yokes (1) which ride on cam blocks located on eccentrics on a camshaft (2). The pistons reciprocate in opposed valve chambers (3), each housing two inlet (4) and outlet valves (5) and springs. A sealing plug and snap ring secure the valves in the chambers.

Front and rear pump body castings incorporate the oil galleries connecting the valve chambers, and house the control valve and the oscillator.

Attached to the rear body is the Response control (6) and strainer housing (7) and also the pressure relief valve (8).

The pressure relief valve is not adjustable and is connected to the outlet port of the pump to the lift cylinder. As each of the pump pistons moves in its cylinder it creates suction which lifts the inlet valve from its seat and draws in oil past the control valve (if open) along the intake gallery into the cylinder. During this inlet stroke the outlet valve is held closed by the spring acting on it. When the piston reaches the end of its inlet stroke, the suction ceases with the cylinder, now full of oil, allowing the inlet valve to be closed by the inlet valve spring.

As the piston begins its compression stroke, the resultant pressure in the oil keeps the inlet valve closed and lifts the outlet valve, forcing the oil past the outlet valve into the high pressure gallery and up the stand pipe to the ram cylinder.

Pump control valve. (Fig. 3 to Fig. 5).

The function of the pump control valve is to control the oil flow to and from the hydraulic system. In order to carry out this function, it has 3 positions: ‘Intake’ (raise), ‘Neutral’ (stationary) and ‘Discharge’ (lower).

The main advantage of the Ferguson System is that the pump gives a variable flow by controlling the degree of opening of the intake and discharge slots in the control valve assembly giving complete control across the full range.

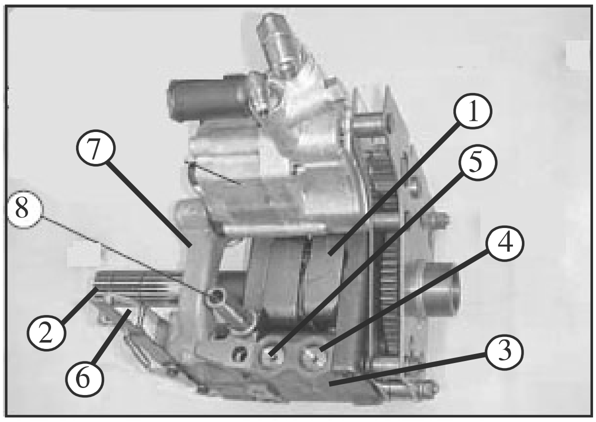


Fig 2

The control valve has intake and discharge slots at either end and is moved into its various operating positions by a vertical lever controlled by the linkage arrangements within the top cover assembly. It is spring loaded to the intake position. The valve is oscillated to prevent it sticking. It slides within a sleeve which has ports leading to the intake and pressure sides of the pump.

In Fig. 3, the vertical lever has moved to allow the valve to move to the intake position under the influence of the spring. This allows oil to be drawn through the intake slots into the pump. In this position, the lift arms would be rising.

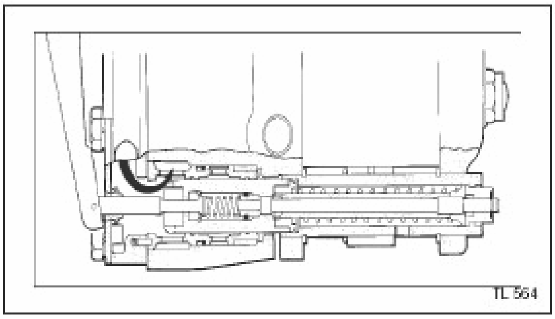


Fig 3

Fig. 4, shows the valve in its neutral position, the intake and discharge slots being outside the ports in the sleeve. In this position, the lift arms would be stationary.

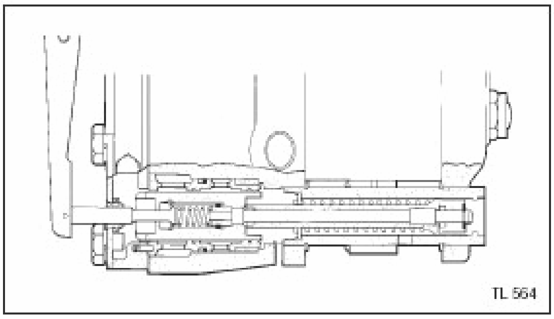


Fig 4

In Fig. 5, the valve is in its discharge position. The discharge slots are open to the pressure chamber allowing oil to flow from the ram cylinder back to sump. In this position, the lift arms would be lowering.

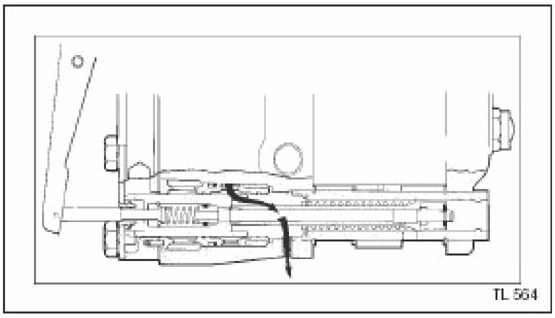


Fig 5

Response Control (Fig. 6):

The principle components of the Response Control mechanism are a non-return valve within the pump intake gallery and an oil discharge orifice, the effective size of which is varied by a slide valve.

Whenever the pump control valve moves to the discharge position it displaces oil from the intake gallery (1). The oil is prevented from returning through the intake filter by the non-return valve (2) and is therefore forced to escape through the orifice (3). Altering the Response Control setting moves the slide valve (4) which varies the size of the orifice and consequently the rate of oil discharge from the gallery. This, in turn, determines the speed at which the control valve moves to discharge and the rate at which the implement lowers.

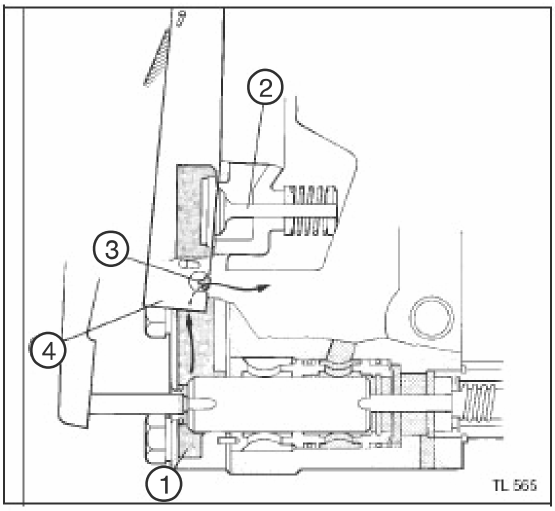


Fig 6

Operation Draft Control - implement lowering. (Fig. 7).

To lower the implement, place the Position Control lever in the Transport position, and move the Draft Control lever down the quadrant. This action presses the eccentric roller (1), on the end of the Draft Control lever shaft, down onto the upper cam face of the Draft Control cam (2), causing the lower face of the cam (2) to be forced downwards into contact with the roller (3) on the Draft Control linkage. The cam (2) is then moved rearward causing the vertical lever (4) to pivot and move the pump control valve, via the lever (5), into the discharge position against the influence of the control valve spring. The Draft Control linkage will move because the force from the control valve is less than the breakout spring (6) force.

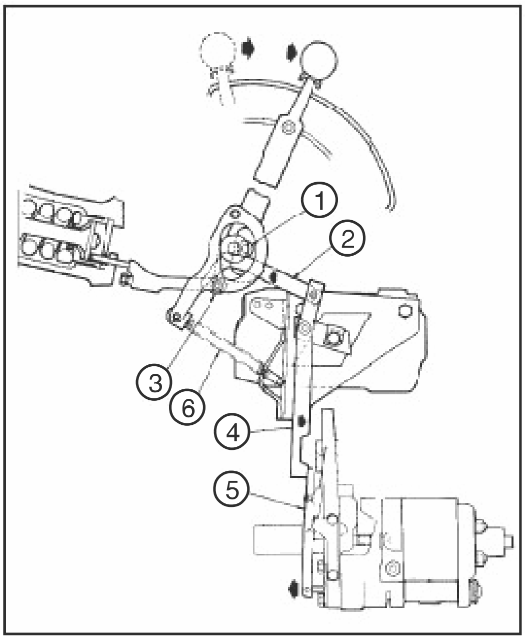


Fig 7

Draft Control - compression force in the top link.(Fig. 8).

When the control valve is in the full discharge position, and with further downward movement of the Draft Control lever, the eccentric roller (3) acting on the upper cam face of the Draft Control cam (4), forces the lower cam face of the Draft Control cam (4) to move the roller (5) forwards. Forward movement of the roller (5) leaves a gap between the Draft Control rod (2) and the Draft Control spring plunger and simultaneously compresses the breakout spring on the guide rod (7). Forward movement of the tractor will cause an implement to gain depth because the control valve is in the discharge position. This will continue until the resultant implement draft reaction compression forces, applied through the top link, deflect the control spring. This causes the Draft Control spring plunger to contact the Draft Control rod (2), and move the Draft Control linkage forwards, acting under the influence of the control valve spring and limited by the position of the roller (5), until the control valve reaches the neutral position.

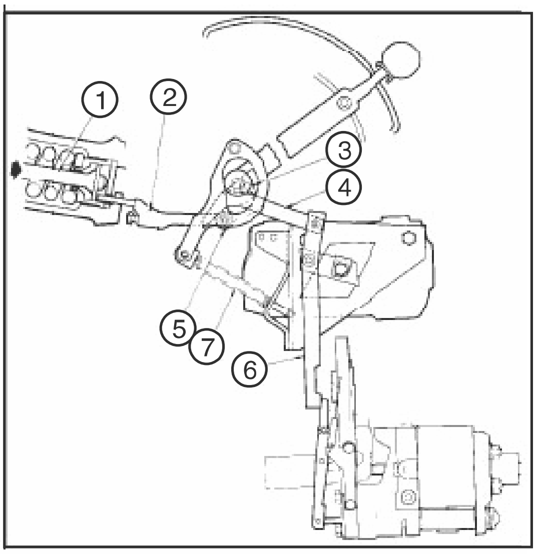


Fig 8

Draft Control - tension force in the top link (Fig. 9).

Variations in ground conditions will cause fluctuations in the draft force in the top link. If the draft force decreases, the compression force in the control spring decreases. The Draft Control linkage follows the control spring plunger under the influence of the breakout spring in the guide rod (7), and moves the Draft Control link rearwards. The vertical lever (4) pivots and moves the pump control valve, via the lever (5), towards discharge. When the correct depth is obtained, the valve is restored to neutral. An increase of draft force in the top link will have an opposite effect.

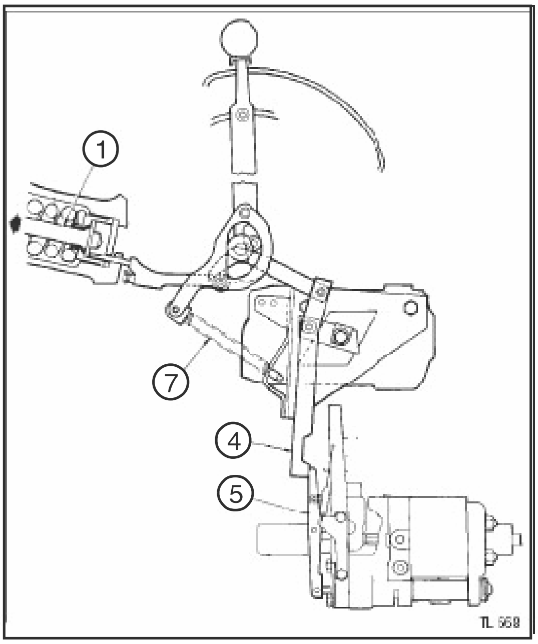


Fig.9

Position Control - implement lowering (Fig. 10).

With the Draft Control in the fully UP position downward movement of the Position Control Lever causes the eccentric roller (2) to force the cam (3) downwards. The breakout spring pushes the Position Control link (1) to maintain contact between the roller (8) and the eccentric cam on the cross shaft (9), and the front roller (6) moves the cam (3) rearwards, causing the vertical lever to pivot and move the pump control valve, via the lever (5) into the discharge position.

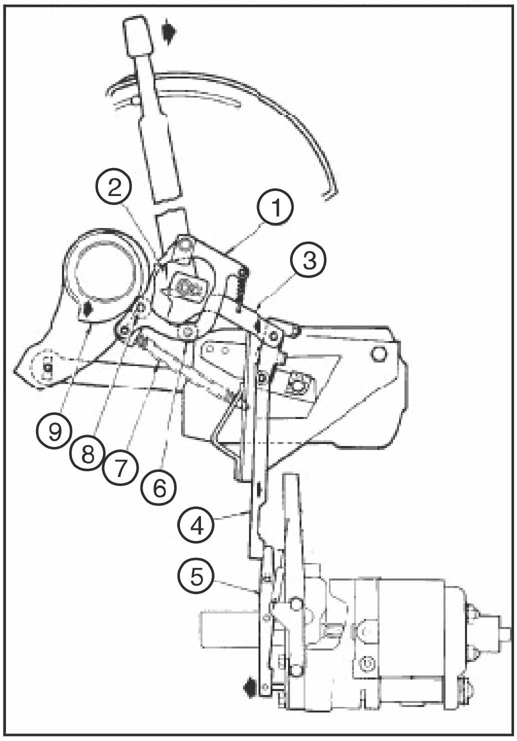


Fig.10

Position Control - implement raising. (Fig. 11).

Release of oil from the ram cylinder allows the eccentric cam on the cross shaft (5) to rotate and force the rear roller (4), mounted on the Position Control link (1), forward. This action allows the pump control valve spring to move the Position Control cam (2), which is in contact with the front roller (3), forward, until the control valve reaches the neutral position, which has been determined by the Position Control lever.

For every position that the Position Control lever is moved to, there is a position where the cam moves the control valve to neutral.

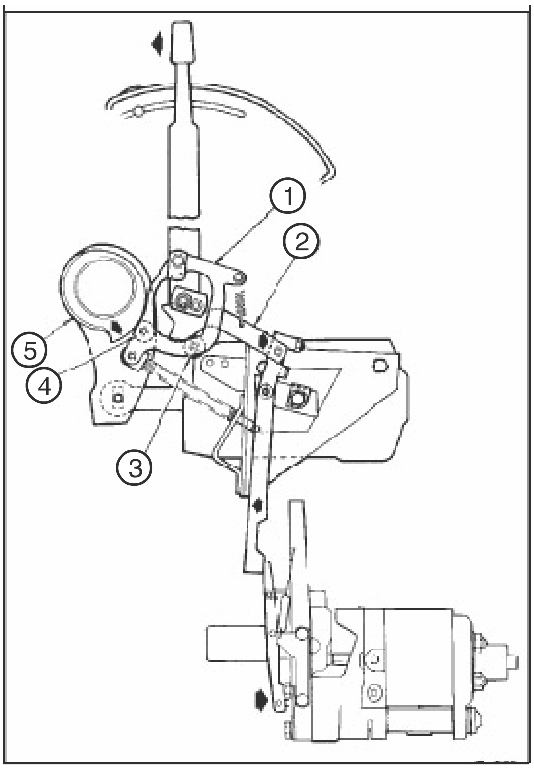


Fig 11

11A . 3 CONTROL SPRING ASSEMBLY

Removal and refitment (Refer Fig 12)

Special Tools:

MF163 - Wrench

Removal:

1. Remove the control beam.
2. Remove the hexagon socket screw.
3. Pull back the rubber boot.
4. Using MF.163, unscrew the retainer from the lift cover.
5. Withdraw the control spring assembly from the lift cover.
6. Remove and discard the nylon plug.

Refitment:

7. Reverse procedures 1 to 6, except:
   a. With the Draft Control lever in the fully DOWN position, tighten the retainer, until the end-float is eliminated. Do not over-tighten otherwise the end float will reappear.
   b. Fit a new nylon plug.
   c. Tighten the hexagon socket screw to a torque of 5 lbf.ft (7 Nm).

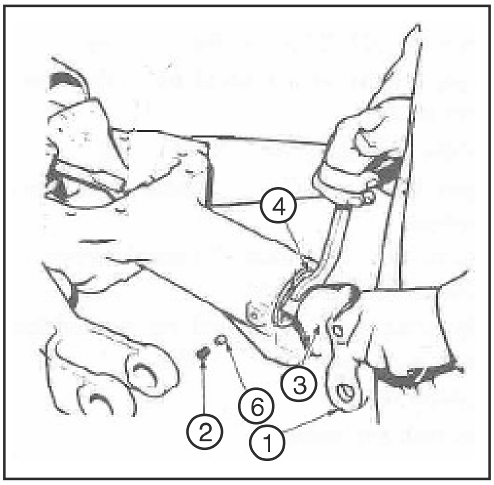


Fig 12

11A . 4 CONTROL SPRING ASSEMBLY

Overhaul (Refer Fig 13)

Special Tools:

MF163 Wrench

Dis-assembly

1. Remove the control spring assembly, see operation 11A . 3
2. Drive out the pin.
3. Unscrew the head using MF.163 wrench
4. Remove the retainer.
5. Remove the spring.
6. Remove the spring seat.

Re-assembly

7. Reverse procedures 1 to 6, except:
   a. Screw the plunger into the head until the end-float is eliminated and the spring is tight to turn by hand.
   b. Fit a new pin.

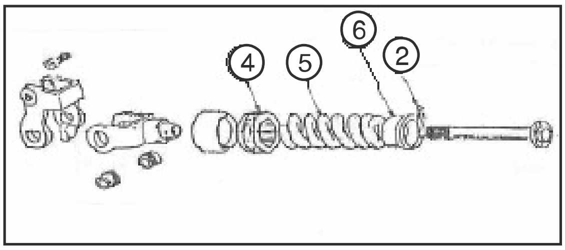


Fig 13

11A . 5 HYDRAULIC LIFT COVER

Removal and refitment (Refer fig 14 , 15 ,16)

Special Tools:

MF226C Lift cover remover/replacer

Removal

1. Disconnect the lift rods from the lift arms.
2. Remove the control beam.
3. Place the Draft Control lever in the fully DOWN position.
4. Remove the two bolts and washers.
5. Remove the cap and stand-pipe,
6. Place the Draft Control lever in the fully UP position and the Position Control lever in the Transport position and lock in position.
7. Remove the lift cover bolts.
8. Using MF.226C carefully hinge back the lift cover and place the support leg on the ground.
9. Remove and discard the lift cover gasket.
10. Drain the oil to the LOW mark on the dipstick.
11. Remove the screws attaching the Response Control cover plate.
12. Remove the response cover plate.
13. Remove the four bolts and one screw attaching the right-hand side cover to the centre housing.
14. Disconnect the Constant Pumping control rod, if fitted. Remove the side cover.
15. Remove and discard the side cover gasket.

Refitment

16. If any work has been carried out on the lift cover, carry out the static adjustments before refitment
17. Clean the surfaces of the centre housing and lift cover.
18. Reverse procedures 1 to 15 except:
    a. DO NOT replace the lift cover gasket. Coat the face of the centre housing and lift cover with MF Instant Gasket (Loctite 509, 5204 or 5205).
    b. Take care, when refitting the lift cover that the vertical lever does not foul any of the internal components.
    c. Do not forget to fit the stand pipe and cap.
    d. Tighten the lift cover bolts to a torque of 65 lbf. (88 Nm).
    e. Tighten the Transfer cap retaining bolts to a torque of 32 lbf.ft (44 Nm).
19. Carry out external adjustments, see operation 11A . 10.

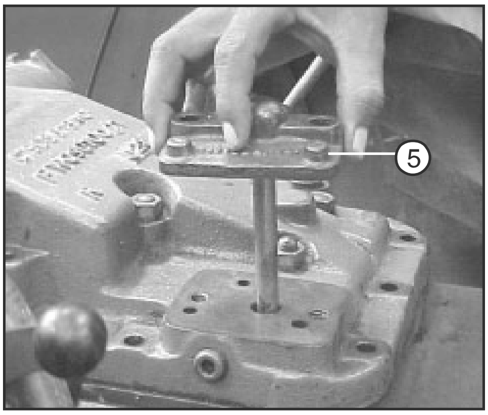


Fig 14

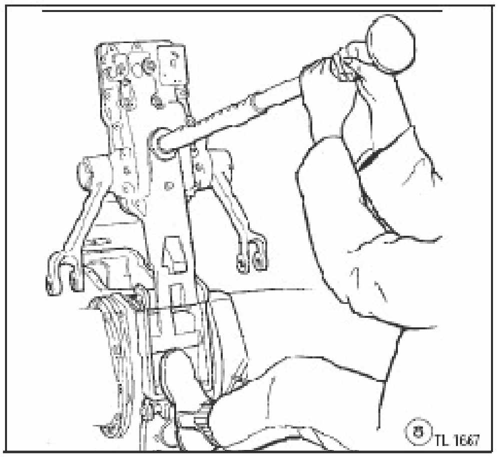


Fig 15

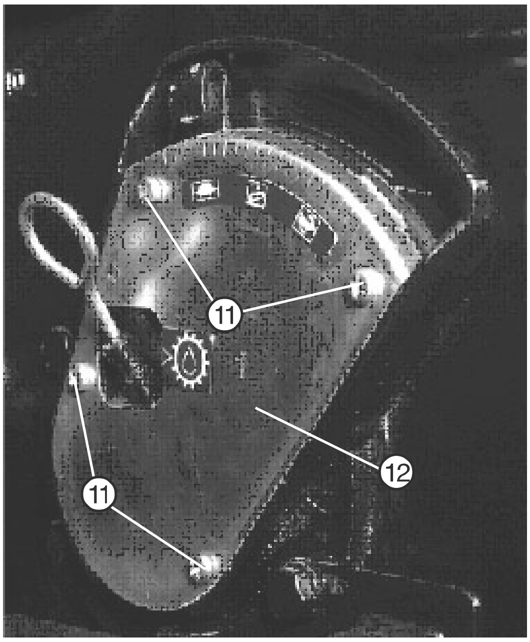


Fig 16

11A . 6 HYDRAULIC LIFT COVER

Overhaul: (Refer 17 to 23)

Dis-assembly:

1. Remove the lift cover, See operation 11A . 5
2. Release the tabwasher.
3. Remove the nut.
4. Remove the tabwasher.
5. Remove the spacer.
6. Release the spring.

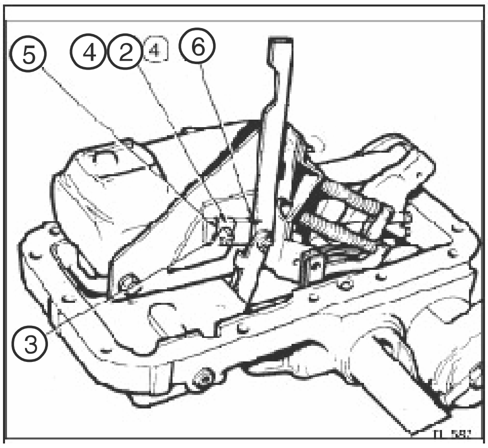


Fig 17

7. Release the slide pivot from the bolt.
8. Remove the spring.

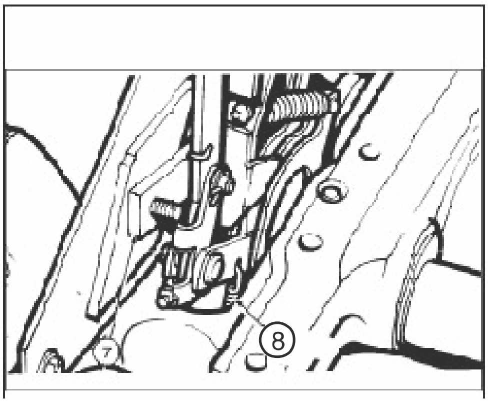


Fig 18

9. Fit a pair of pins to retain the springs.
10. Remove the four nuts securing the ram cylinder to the lift cover.
11. Lift off the ram cylinder.

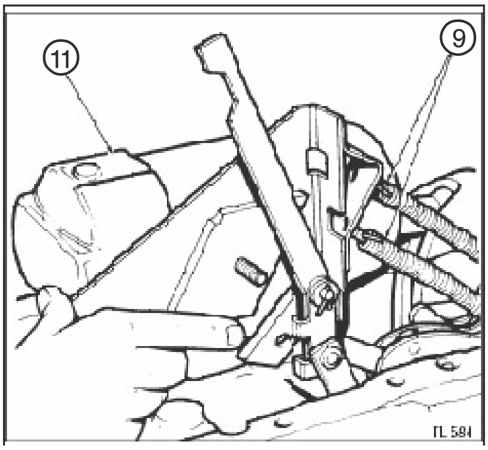


Fig 19

12. Remove and discard the ‘O’ ring.
13. Remove the connecting rod.
14. Remove the hexagon socket screw. On later models the hexagon socket screw is replaced by a roll pin.
15. Remove the hexagon socket plug.
16. Remove the screw.
17. Screw a Number 10-32 UNF bolt into the pin and remove the pin.

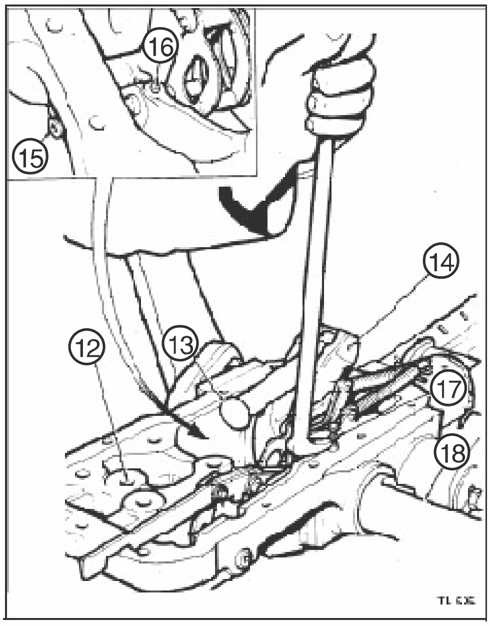


Fig 20

18. Withdraw the quadrant control support assembly, simultaneously lifting out the vertical lever and the cams.
19. Remove the shim(s), if fitted.
20. Remove the Belleville washer.

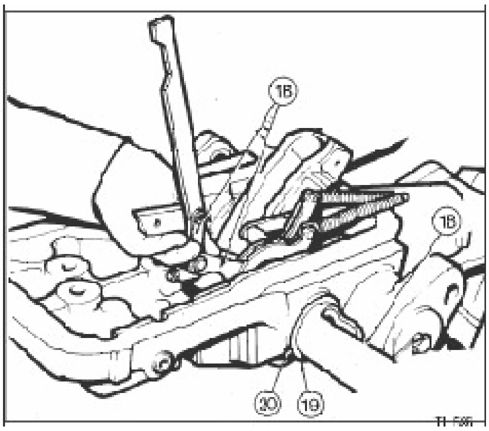


Fig 21

21. Withdraw the pivot shaft.
22. Lift out the links.
23. Release the tabwasher.
24. Remove the bolt and washer.
25. Slide off the lift arm.
26. Remove and discard the ‘O’ ring.
27. Release the tabwasher.
28. Remove the bolt and washer.
29. Slide off the lift arm.
30. Remove the ‘O’ ring, see procedure 26.
31. Drive the lift shaft out of the lift cover.
32. Remove the ram arm.
33. Remove the two bushes.

Re-assembly

34. Reverse procedures 1 to 33, except:
    a. Fit new bushes if necessary.
    b. Fit new ‘O’ rings and tab washers.
    c. Align the master spline when refitting the shaft and the two lift arms.
    d. Fit the Belleville washer with the concave side towards the lift cover.
    e. Ensure that the pivot shaft is fully located against the side of the lift cover before tightening the hexagon socket screw.
    f. When refitting the connecting rod hexagonsocket screw, apply a drop of MF Lock and Seal (Loctite 542) or equivalent to the threads, and screw the hexagon socket screw into the ram arm until the screw bottoms on the annular groove in the connecting rod, then back it off 1/4 turn.
    g. When refitting the ram cylinder, locate the connecting rod in the piston and the two rods in the holes in the bracket.
    h. Tighten the front ram cylinder retaining nuts to a torque of 162 lbf.ft (220 Nm) and the rear retaining bolts to a torque of 225 lbf.ft (305 Nm).
35. Carry out hydraulic static adjustments, see operation 11A . 9.

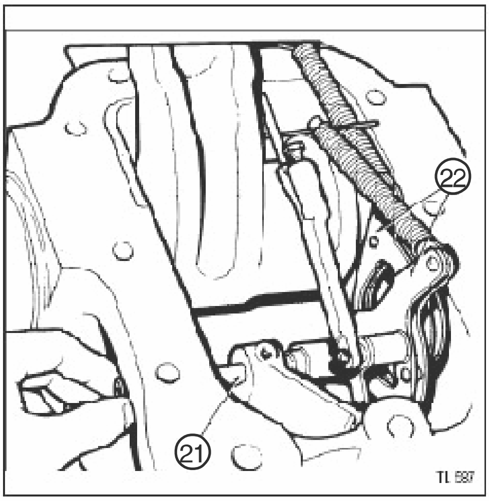


Fig 22

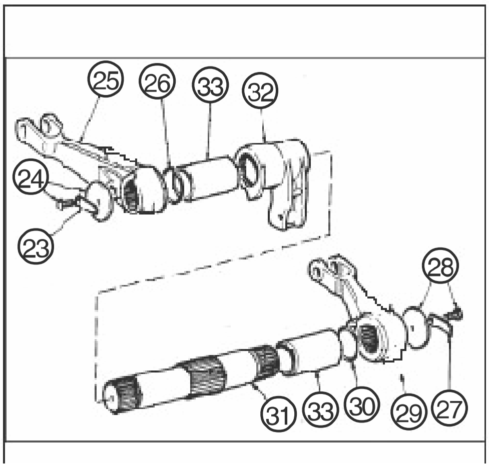


Fig 23

11A . 7 HYDRAULIC LIFT CYLINDER

Overhaul

Special Tools:

MF420 Piston seal replacer 3.110 inch (79 mm).

Dis-assembly

1. Remove the lift cylinder assembly, See operation 11A . 6, procedures 1 to 11.
2. Remove the two bolts.
3. Remove the support bracket.
4. Withdraw the piston from the cylinder.
5. Remove the piston seal and ‘O’ ring if necessary.

Examination

Examine all components for wear or damage, replacing any defective components.

Re-assembly

6. If piston seals have been removed apply transmission oil to ‘O’ ring part of seal and fit it into the piston groove.
7. Lubricate the outside of the tapered guide of MF.420 for the MF.2605/2615 tractors, with mineral oil. Place the guide on a firm, flat surface. Locate the seal on the guide and very carefully push the seal down the taper of the guide until it protrudes beyond the end. Locate the lip of the seal on the piston at the closed end. Push the seal off the guide onto the piston and into the groove on top of the ‘O’ ring.
8. Push the piston into the wide bore end of the sizing ring. Push it through until it protrudes approximately 0.472 inch (12 mm) from the end of the ring.
9. Lubricate the bore of the cylinder with transmission oil, then locate the protruding portion of the piston in the mouth of the cylinder bore. Push the piston through the sizing ring and into the cylinder.
10. Reverse procedures 1 to 11 in operation 11A . 6.

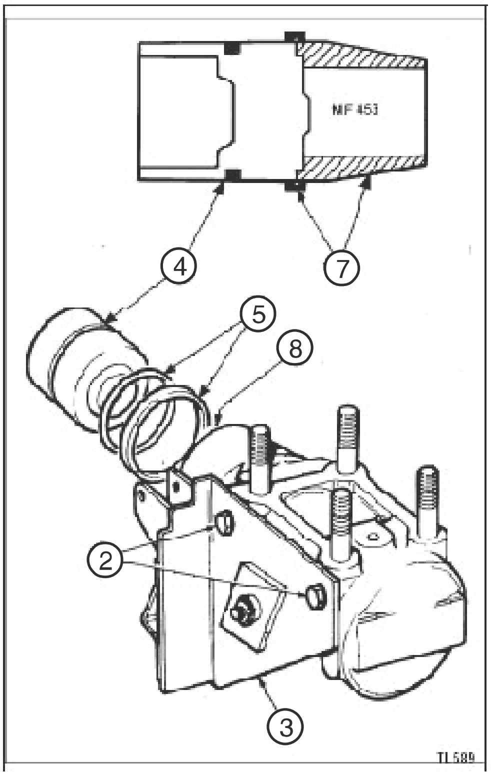


Fig 24

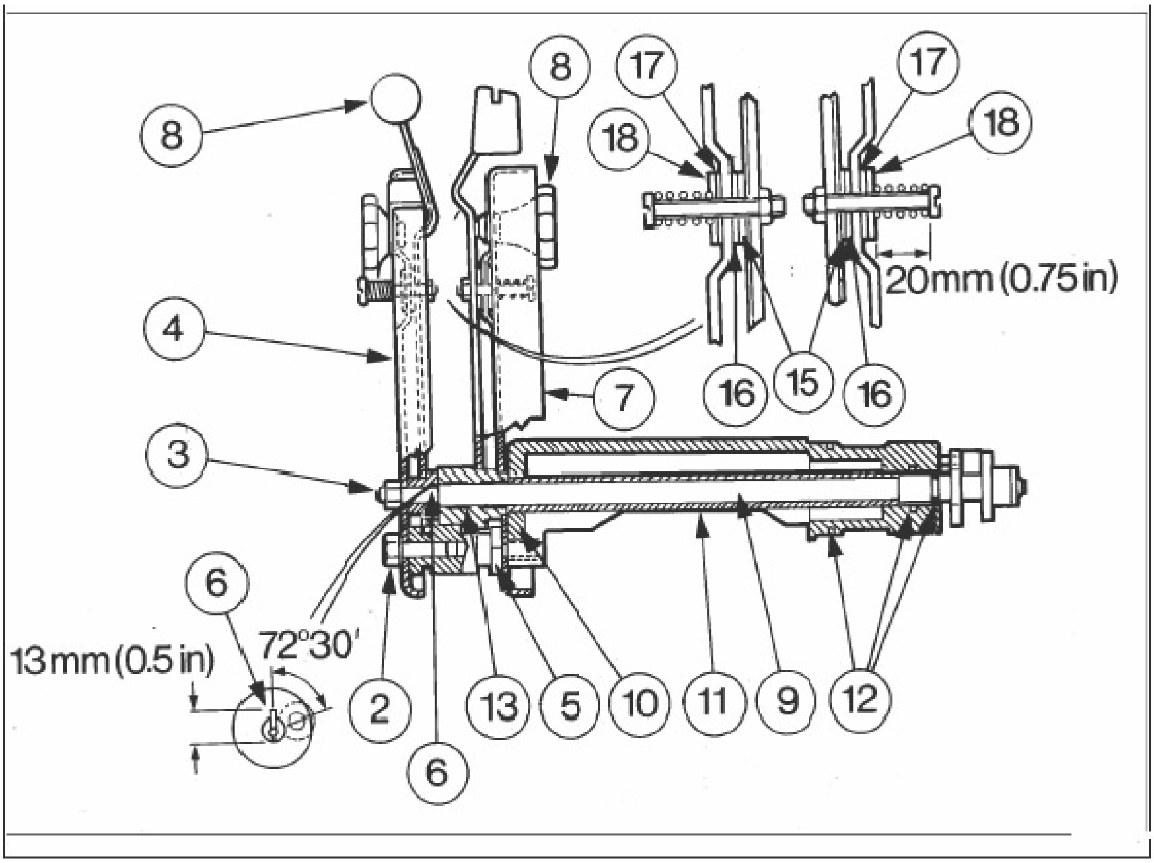


Fig 25

11A . 8 QUADRANT AND SUPPORT ASSEMBLY

Overhaul

Dis-assembly

1. Remove the quadrant control support assembly, see operation 11A . 6, procedures 1 to 12 and 17 to 20.
2. Remove the two bolts and washers.
3. Remove the nut.
4. Remove the outer quadrant complete with lever.
5. Remove the two spacer bolts.
6. Drive out the pin.
7. Remove the inner quadrant complete with the lever.
8. If necessary, remove the levers and the stop knobs.
9. Withdraw the Draft Control shaft.
10. Remove the circlip.
11. Withdraw the Position Control shaft.
12. Remove the ‘O’ rings.
13. Remove the bush.

Re-assembly:

14. If necessary, refit the levers and the stop knobs to the quadrant. Assemble the washers in the order shown in the following procedures 15 to 19.
15. Fit the steel washers.
16. Fit the polyurethane washer with the shiny side against the quadrant.
17. Fit the nylon washers.
18. Fit the steel washers.
19. Tighten the screws to give a clearance of approximately 0.787 inch (20 mm) between the screw head and the steel washer.
20. Reverse procedures 1 to 13 except:
    a. Do not overtighten the Draft Control shaft nut and locknut as the roller will not turn freely.
    b. Refit the pin (procedure 6) with the shaft and roller in the position shown and protruding approximately 0.511 inch (13 mm) from the shaft.

11A . 9 HYDRAULIC STATIC ADJUSTMENTS

Adjust

Special Tools:

MF163	Spring retainer nut wrench
MF272	Ram arm gauge
MF333	Draft Control rod gauge
MF356C	Position and Draft Control setting gauge
MF273 A	Hydraulic control lever setting fixture

Control spring internal end-float:

1. Remove the locking pin.
2. Screw the plunger into the yoke until all the end-float has been removed and the spring is tight to turn by hand.

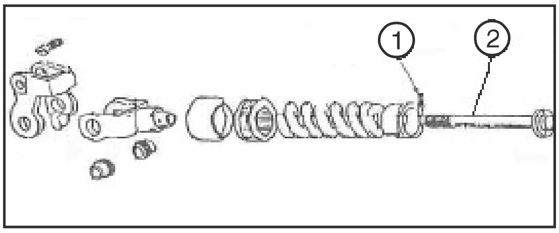


Fig 26

Control Spring external end-float :

1. Ensure that the Draft Control rod cannot obstruct the control spring plunger by fitting a suitable wedge between the draft rod adjusting bolt and the lift cover casting. If the lift cover is fitted, move the Draft Control lever to the fully lowered position.
2. Refit the spring assembly into the lift cover housing and using MF.163, tighten the retaining nut until the end float in the spring assembly has been removed. Do not over tighten as this will compress the spring and cause the end-float to return.
3. Tighten the hexagon socket screw to a torque of 5 lbf.ft (7 Nm).
4. Remove the wedge.

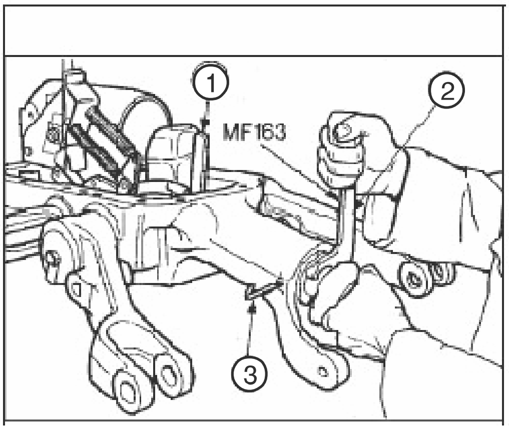


Fig 27

Lift arm end float adjustment

1. Release the tabwasher.
2. Slacken the bolt.
3. Release the tabwasher.
4. Fully tighten the bolt.
5. Secure the bolt and the tabwasher.
6. Tighten the bolt, until the lift arms will move freely throughout their range, but without end float.
7. Secure the bolt with the tabwasher.

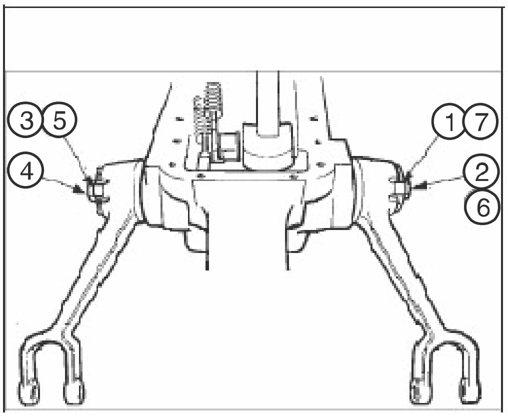


Fig 28

Quadrant location:

1. Slacken the two bolts.
2. Slacken the two barrel nuts.
3. Locate the inner quadrant in the centre of the elongated hole.
4. Tighten the two barrel nuts.
5. Locate the outer quadrant in the centre of the elongated hole.
6. Tighten the two bolts.

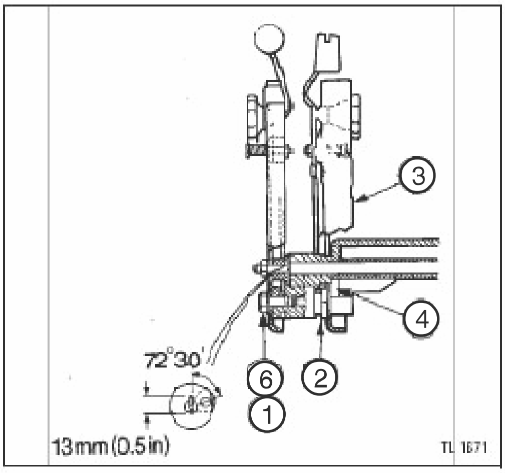


Fig 29

Draft Control rod adjustment

1. Place the Draft Control lever in the UP position.
2. Place the Position Control lever in the Transport position.
3. Using MF.333, adjust the set screw to give a clearance of 0.228 inch (5.8 mm) between the set screw and the lift cover casting.

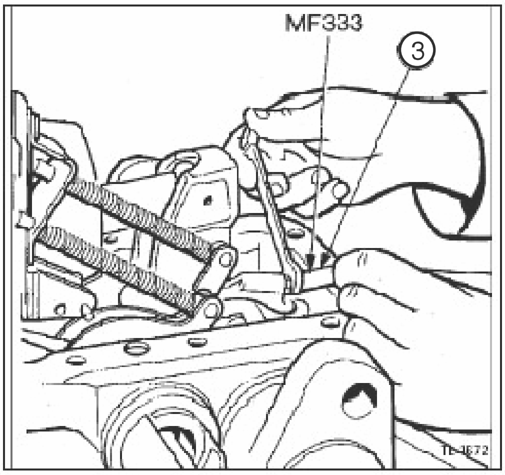


Fig 30

Draft Control neutral setting

1. Slacken the locknut.
2. Slacken the hexagon socket grub-screw and locknut on the vertical lever to the end of its thread. This will ensure that no interference from the Position Control linkage takes place.
3. Release the tabwasher.
4. Slacken the nut.
5. Position MF.273 A on the lift cover.
6. Apply a load of 1.3 kg (2.86 lbs) to the end of the vertical lever. This simulates the force of the linkage pump control spring (a spring balance can be used if no tool is available).
7. Locate MF.356C on the lift cover
8. Place the Draft Control lever in the Sector position.
9. Place the Position Control lever in the Transport position.
10. Adjust the slide pivot, until the vertical lever just touches the pin on MF.356C.
11. Tighten the nut.
12. Re-check the setting.
13. Secure the nut with the tabwasher.

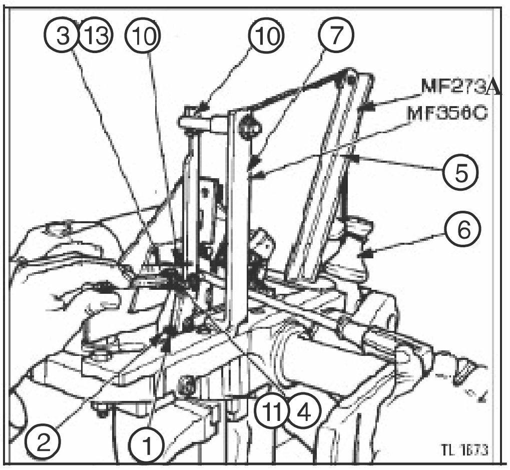


Fig 31

Position control neutral (Transport) setting

1. Position MF.272 on the lift cover.
2. Locate the ram arm on MF.272.
3. Place the Draft Control lever in the UP position.
4. Place the Position Control lever in the Transport position.
5. Adjust the Allen screw until the vertical lever just contacts the pin on MF.356C.
6. Tighten the locknut.
7. Re-check the setting.
8. Remove MF.272, MF.273 A and MF.356C.

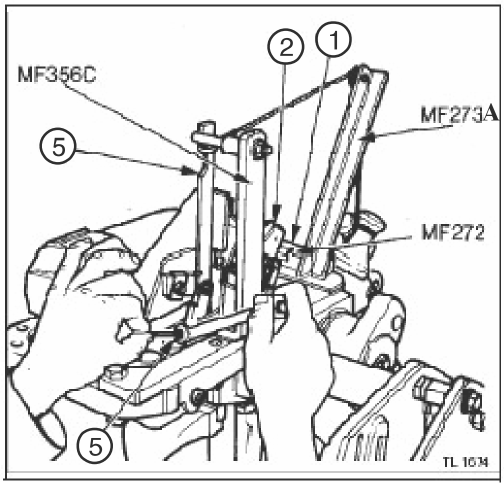


Fig 32

11A . 10 HYDRAULIC EXTERNAL ADJUSTMENTS

Adjust

Pre-conditions

1. Refit the lift cover, hydraulic unions, pipes etc.Refill the tractor with oil to the correct grade.
2. Attach a weight of 400 kg (882 lbs) to the lower links.
3. Place the Draft Control lever in the fully UP position.
4. Start the engine and set the engine speed at low idle (1200 rpm) no load, then operate the Position Control lever through the quadrant range to expel all the air from the system.
5. Warm up the engine oil in the transmission to a temperature of 120 -140 °F (50 - 60°C) and then stop the engine.

Draft Control setting:

NOTE: *The top link must not be attached when carrying out this adjustment.*

1. Start the engine, and set the engine speed at 1200 rev/min.
2. Place the Position Control lever in the Transport position.
3. Using the Draft Control lever, set the lower links in the horizontal position. The Draft Control lever should be in the sector marks on the quadrant, if not carry out procedures 4 to 6.
4. Loosen the two quadrant support bolts and rotate the Draft Control quadrant and lever until the links remain stationary in the horizontal position.
5. Tighten the two bolts and recheck the setting.
6. Fully lower the links and stop the engine.

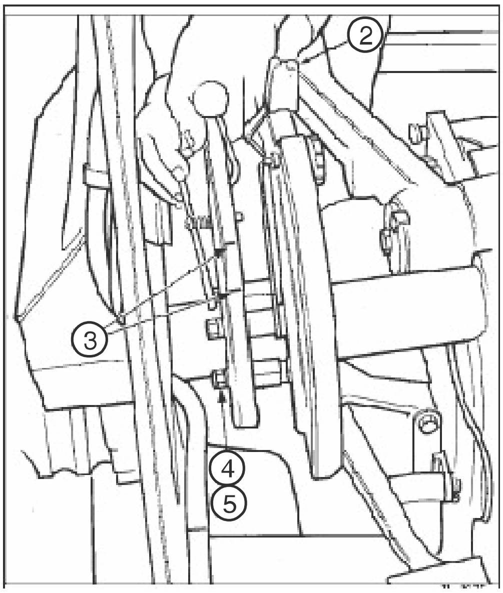


Fig 33

Position control setting

1. Start the engine, and set the engine speed at 1200 rev/min.
2. Place the Draft Control lever in the fully UP position.
3. Place the Position Control lever in the Constant Pumping position.
4. When the links are fully raised scribe a line across the lift cover casting to the lift arm.
5. Place the Position Control lever in the Transport position.
6. The links should drop until the scribe lines are 0.078 - 0.196 inch (2-5 mm) apart, if the distance is incorrect carry out procedures 7 to 10.
7. Slacken the two bolts and the two barrel nuts.
8. Rotate the Position Control quadrant and lever until the setting is correct.
9. Tighten the two barrel nuts and recheck the setting.
10. Stop the engine.

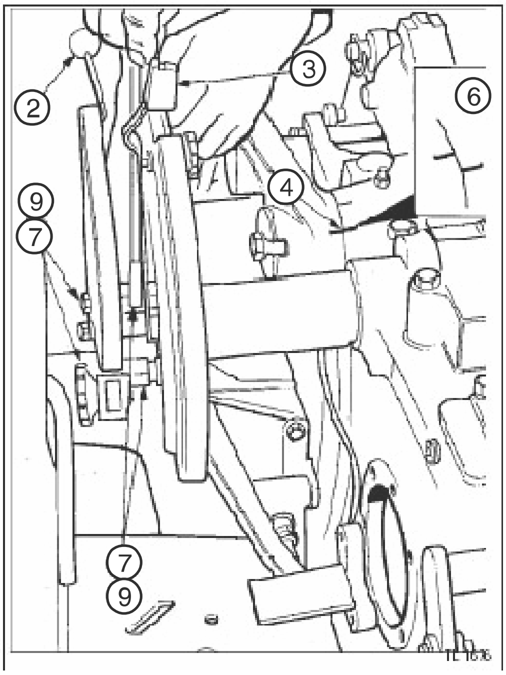


Fig 34

Response Control setting

1. Release the locking screw.
2. Place the Response Control lever 0.236 inch (6 mm) from the rear end of its quadrant.
3. Rotate the inner lever, until the cam just contacts the vertical lever on the hydraulic pump.
4. Tighten the locking screw.
5. Refit the Constant Pumping control rod, if fitted.
6. Refit the cover and secure with the four screws.
7. Add an approved oil to the transmission until the required level is reached.

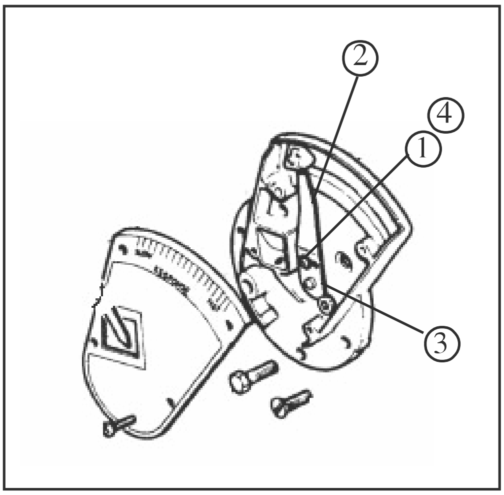


Fig 35

11A . 11 HYDRAULIC PRESSURE TEST

Check

Special Tools:

MF148B	Pressure test gauge
MF3001	Pressure test kit

Procedure

1. Remove the plug from the side of the lift cover and install the 3/8 inch NPT adaptor and quick diagnostic coupling from the MF3001 pressure testing kit or alternatively, connect into the system through the trailer tipping pipe self sealing coupling.
2. Use the 300 bar (5000 psi)gauge in the test kit.
3. Move the Draft Control lever to UP position and the position control lever to Transport position.
4. Start the engine and run at 1200 rev/min. The transmission oil must be at 120-140°F (50-60°C).
5. Move the Position Control lever to Constant Pumping.
6. The system pressure should be: MF.2605/2615 tractors 190 - 225 kg/cm^2 (2702 - 3200 psi)
9. If the pressure setting is incorrect, the relief valve is accessible through the right-hand centre housing side cover.

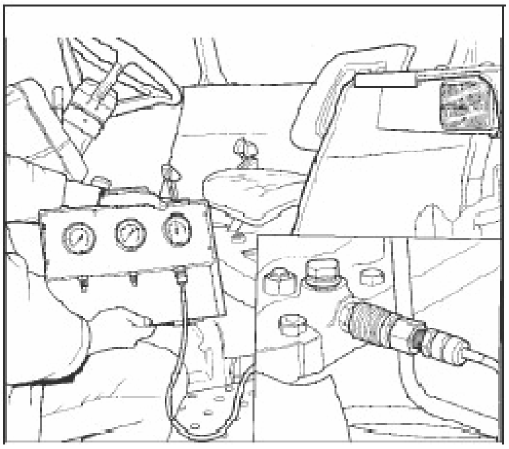


Fig 36

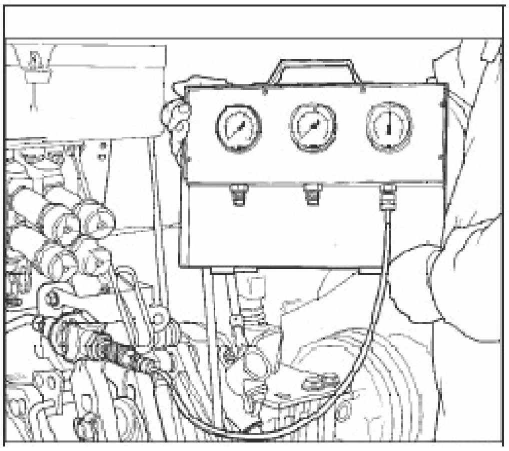


Fig 37

Alternative

9. Connect pressure gauge MF.148B (300 bar / 5000 psi)to the connection on the lift cover.
10. Test the system as described in procedures 3 to 8.

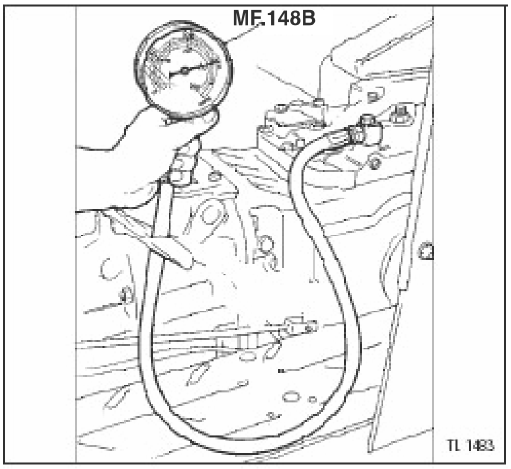


Fig 38

11A . 12 HYDRAULIC LIFT PUMP

Removal and refitment

Removal

Tractors fitted with single speed (540 rev/min) ground speed PTO only.

1. Remove the lift cover. See operation 11A . 5.
2. Drain the transmission oil.
3. Remove the left-hand side cover.
4. Remove the right-hand side cover.
5. Remove the shear tube split pin and discard it.
6. Remove the shear tube and the rear drive shaft.
7. Remove the PTO shaft. See operation
8. Remove the two nuts and dowel pins each side of the transmission case holding the lift pump.
9. Manoeuvre the lift pump out of the top of the centre housing.
10. Remove the coupler.

Refitment

11. Reverse procedures 1 to 10 except:
    a. Fit new split pins, 'O' rings and gaskets.
    b. Fit new shear tube split pin to give 0.014 - 0.100 inch (0.38-2.54 mm) end float.

Tractors fitted with single speed (540 rev/min) IPTO.

Removal

1. Remove the lift cover.
2. Drain the transmission oil.
3. Split the tractor between the centre housing and the gearbox, spacer or transfer gearbox, See operation 4A - 4.
4. Remove the right-hand side cover.
5. Remove the two nuts and dowel pins each side of the transmission case holding the lift pump.
6. Withdraw the lift pump from the front of the centre housing.

Refitment

7. Reverse procedure 1 to 6 except:
    a. Locate the lift pump on to the IPTO clutch if fitted.
    b. Fit new split pins, 'O' rings and gaskets.
    c. Refit the right-hand dowel pin (8) and tighten the two nuts. Fit the left-hand dowel and leave the nuts loose. After re-assembly of the tractor turn the transmission over on the starter motor (stop control out). Fully tighten the left-hand dowel nuts. This procedure is to ensure that PTO and pump shafts are in line.

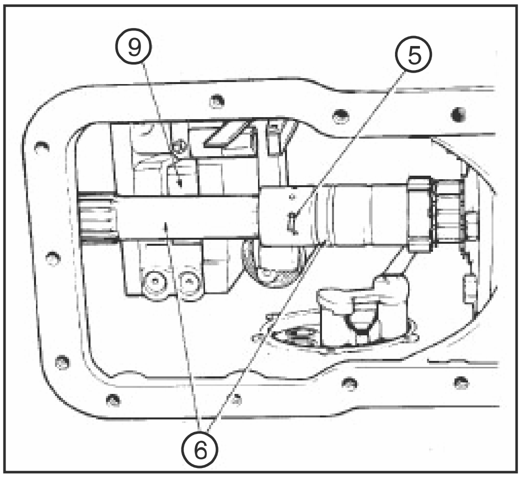


Fig 39

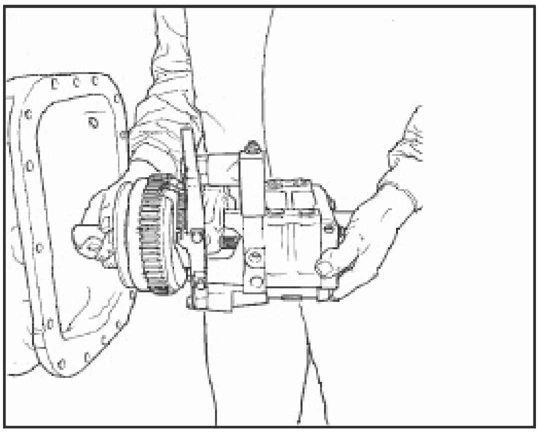


Fig 40

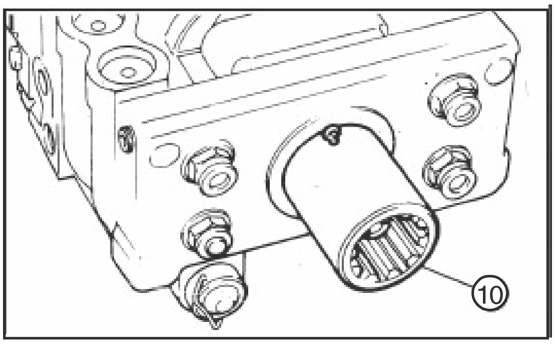
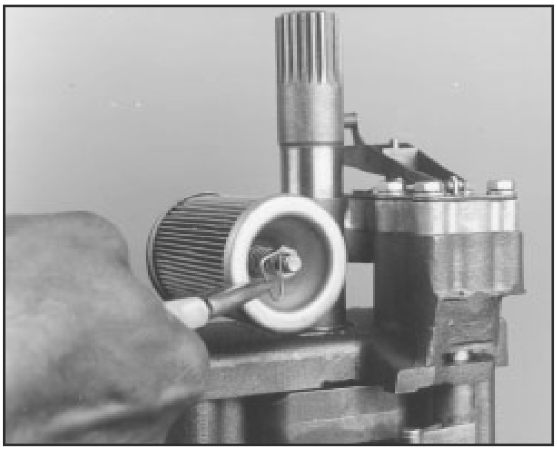


Fig 41

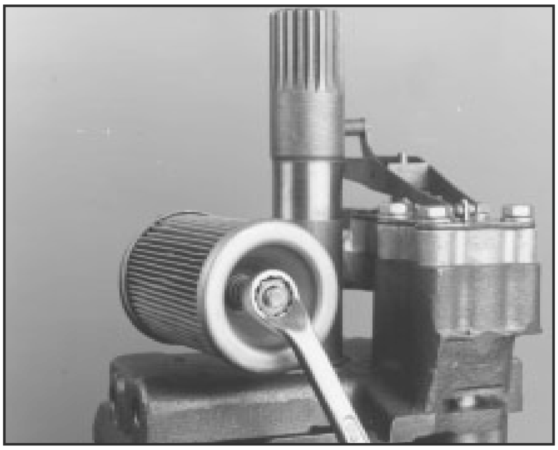
11A. 13 HYDRAULIC PUMP (MARK III)

Dis-assembly

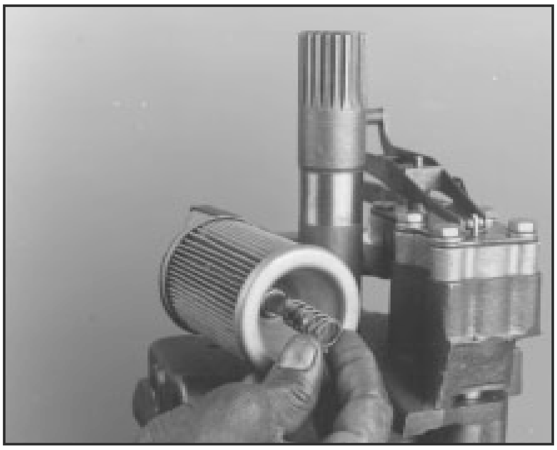
1. Remove the hydraulic pump and keep it vertical.
2. Clean the outside of the pump.



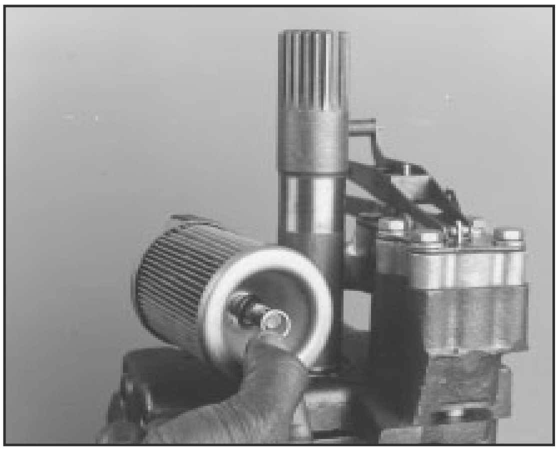
3. Remove the safety clip (fig 42).



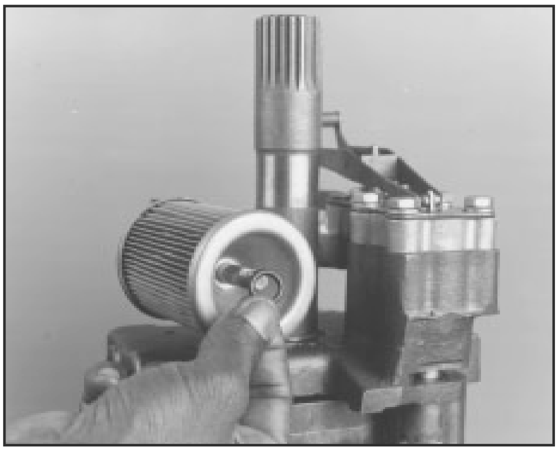
4. Remove the lock nut (fig 43). **(14 mm)**



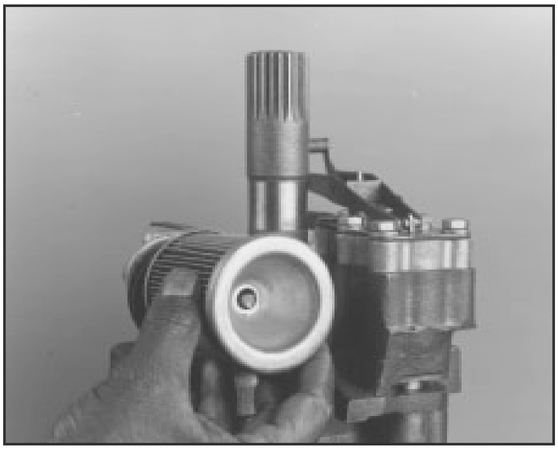
5. Remove the spring (fig 44).



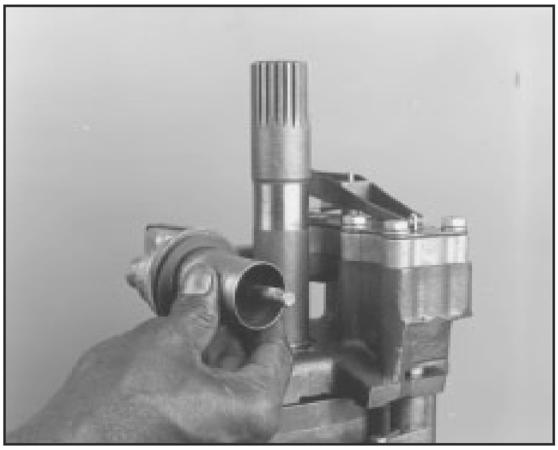
6. Remove the washers (fig 45).



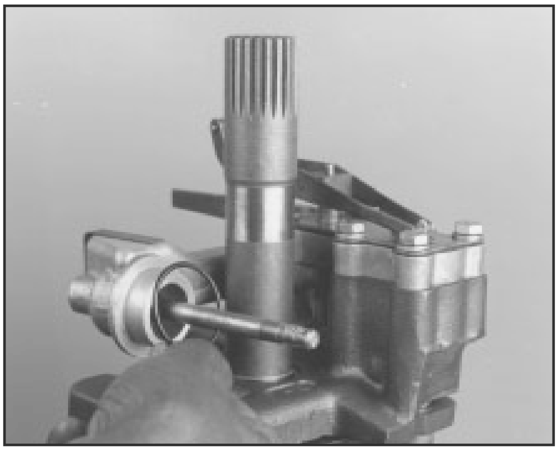
7. Remove the “O” ring and discard it (fig 46).



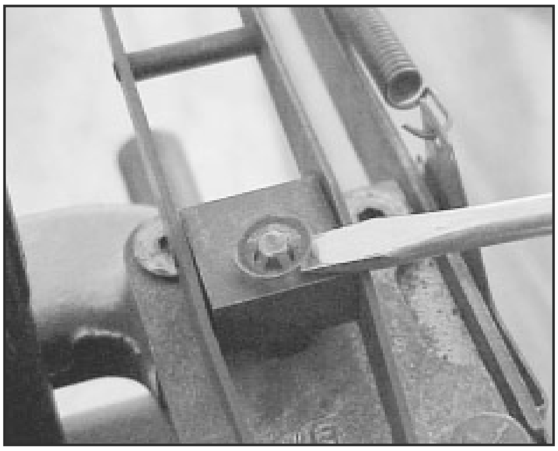
8. Remove the strainer (fig 47).



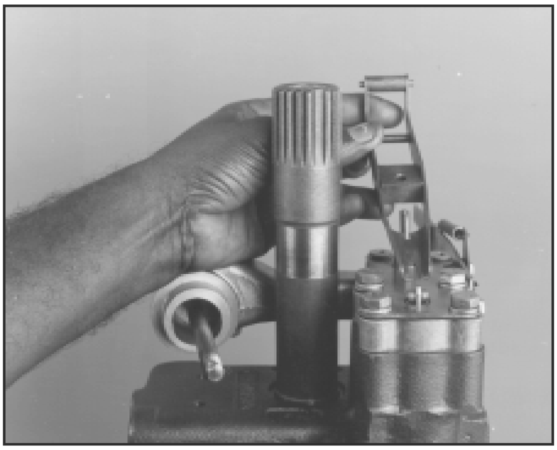
9. Remove the strainer inner shroud (fig 48).



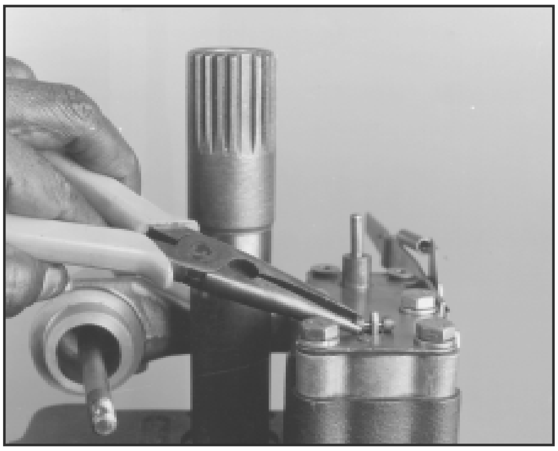
10. Remove the “O” ring and discard (fig 49).



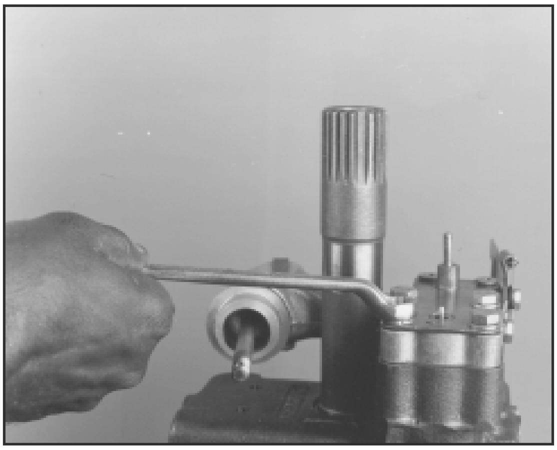
11. Remove the clip (fig 50).



12. Remove the lever (fig 51).

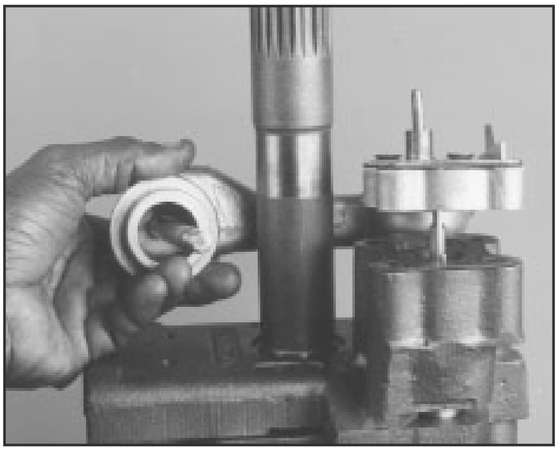


13. Remove the two rollers and the pin (fig 52).

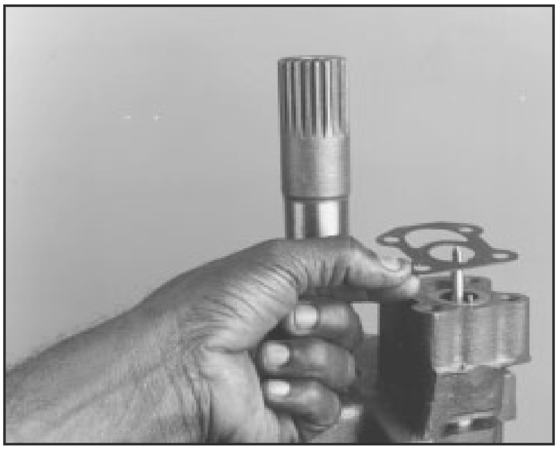


14. Remove the four lower bolts and washers (fig 53).

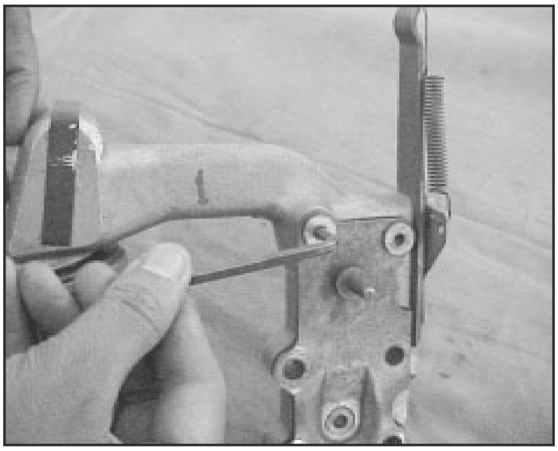
(13 mm)



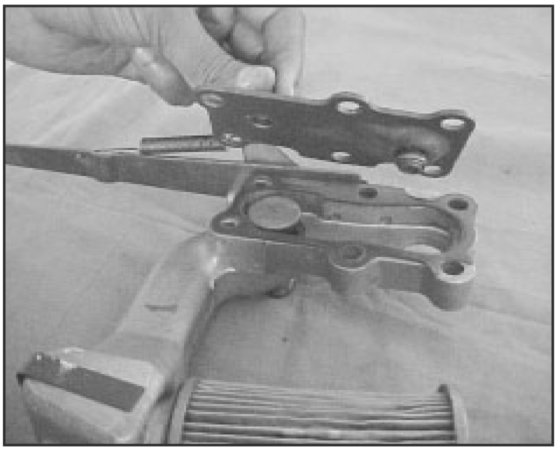
15. Remove the strainer housing (fig 54).



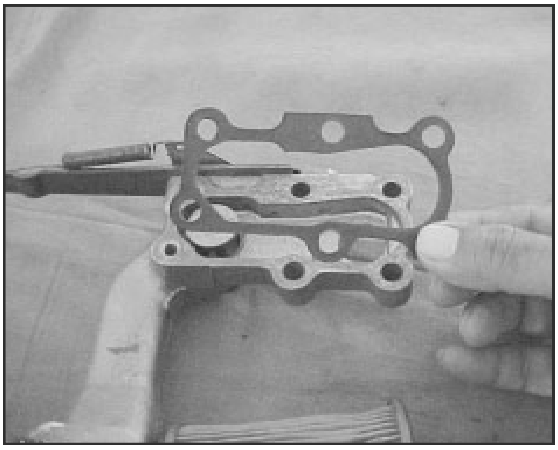
16. Remove the gasket and discard it (fig 55).



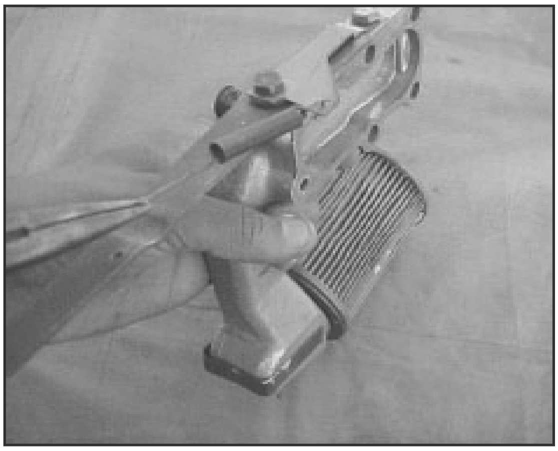
17. Remove the two allen screws (fig 56).



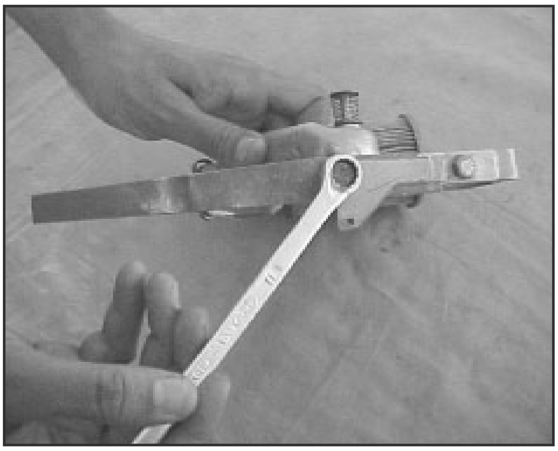
18. Remove the end plate (fig 57).



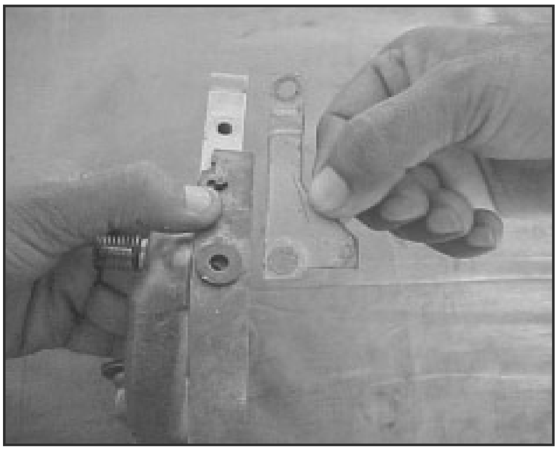
19. Remove the gasket and discard it (fig 58).



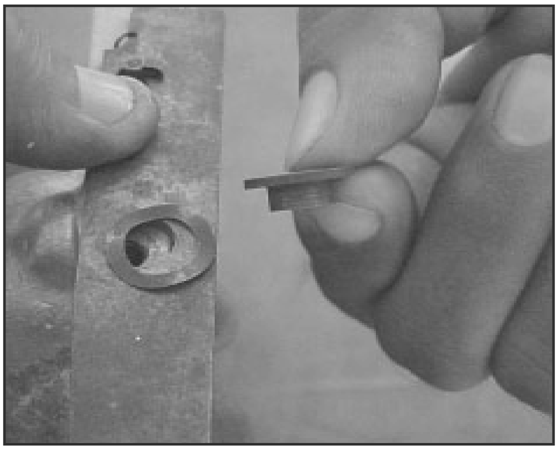
20. Remove the spring (fig 59).



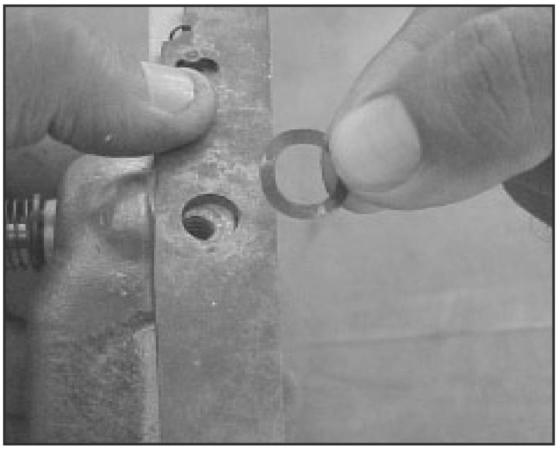
21. Remove the two bolts and washers (fig 60).
(11 mm)



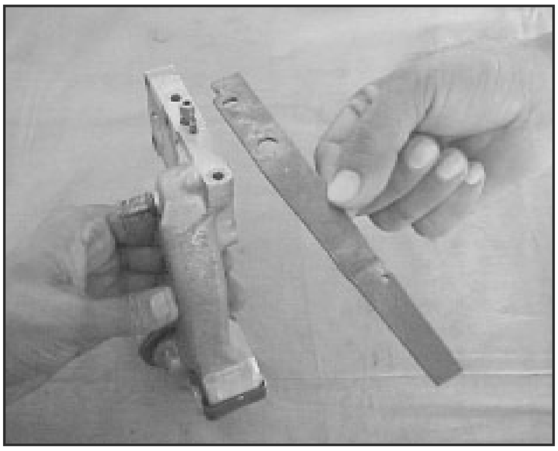
22. Remove the retainer (fig 61).



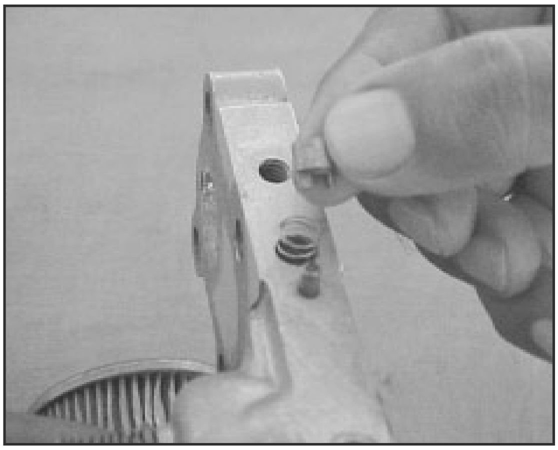
23. Remove the bush (fig 62).



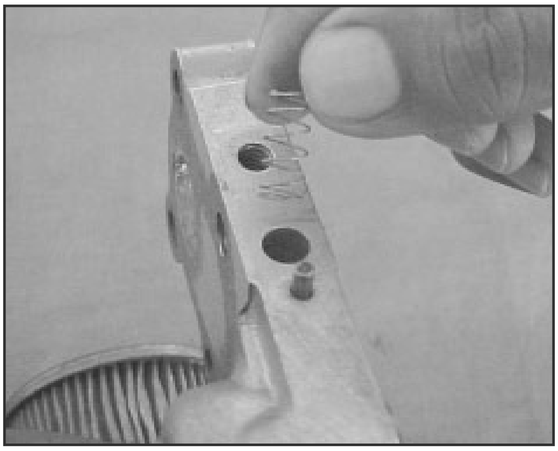
24. Remove the washer (fig 63).



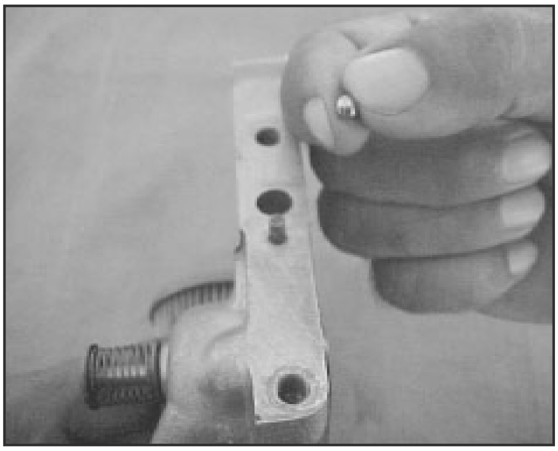
25. Remove the response control lever (fig 64).



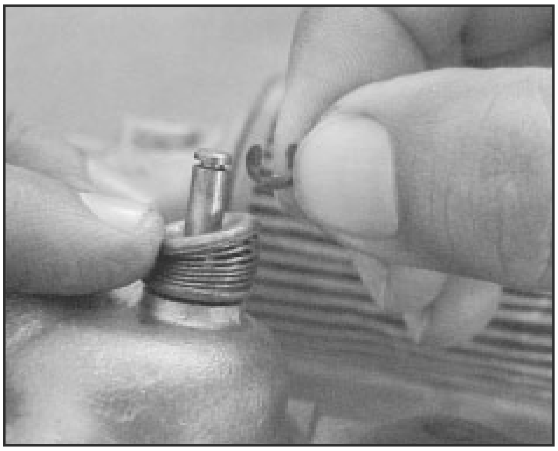
26. Remove the bush (fig 65).



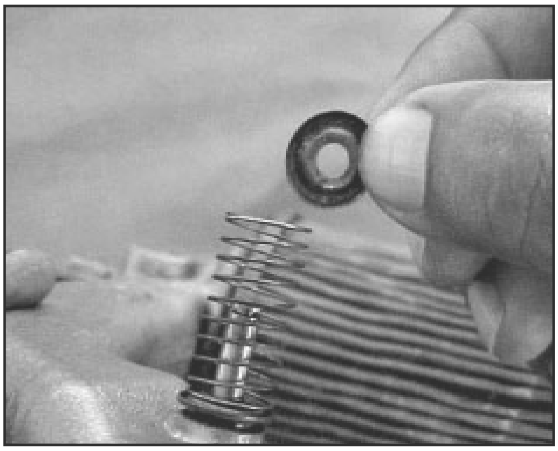
27. Remove the spring (fig 66).



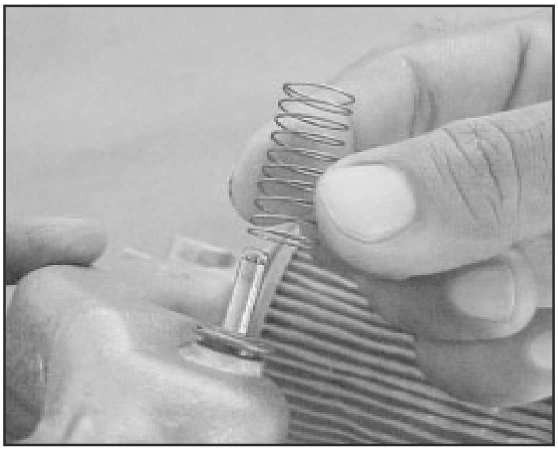
28. Remove the ball (fig 67).



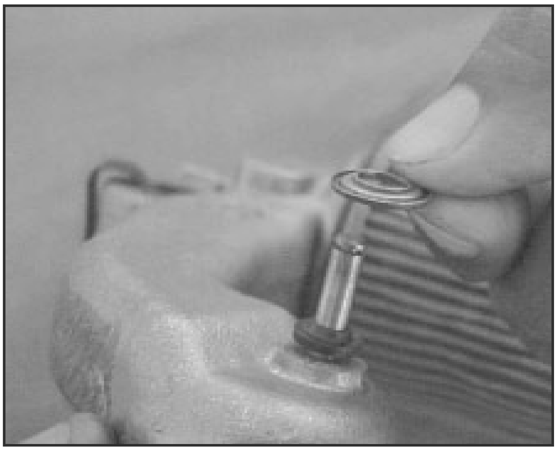
29. Remove the circlip (fig 68).



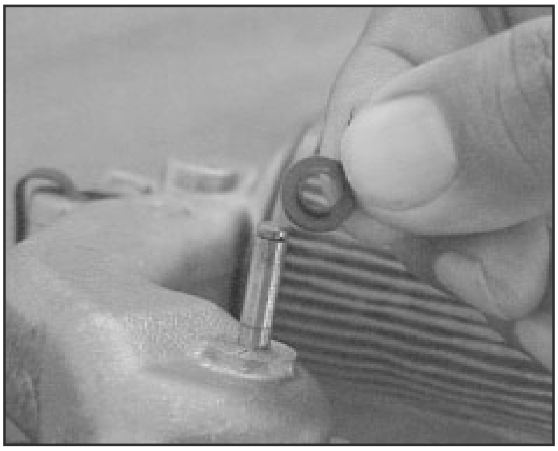
30. Remove the cap (fig 69).



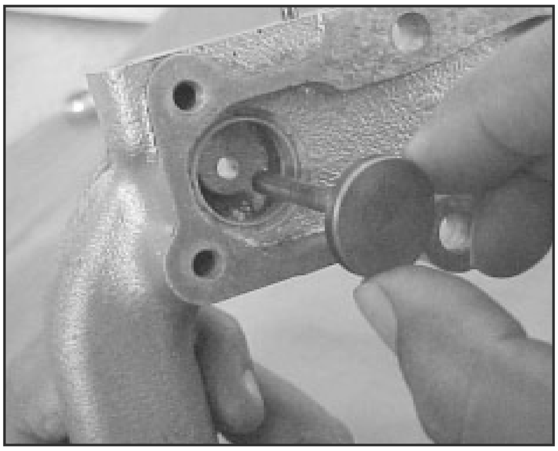
31. Remove the spring (fig 70).



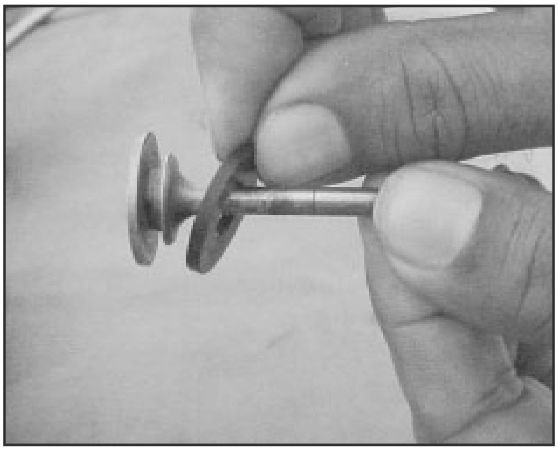
32. Remove the retainer (fig 71).



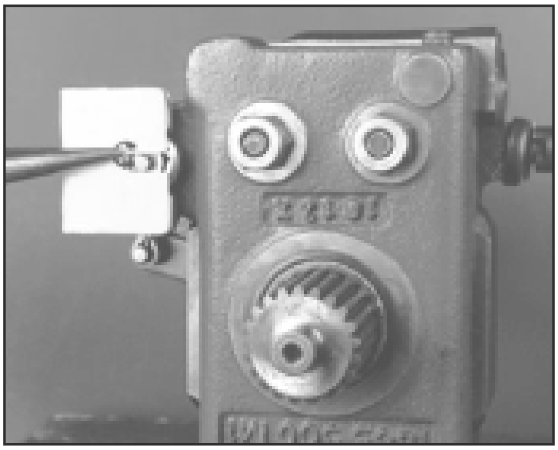
33. Remove the seal and discard it (fig 72).



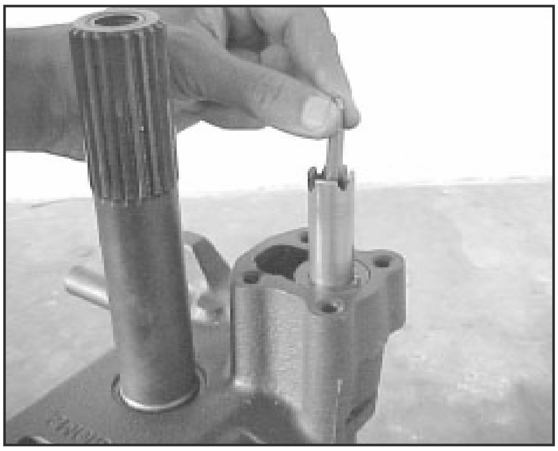
34. Remove the valve (fig 73).



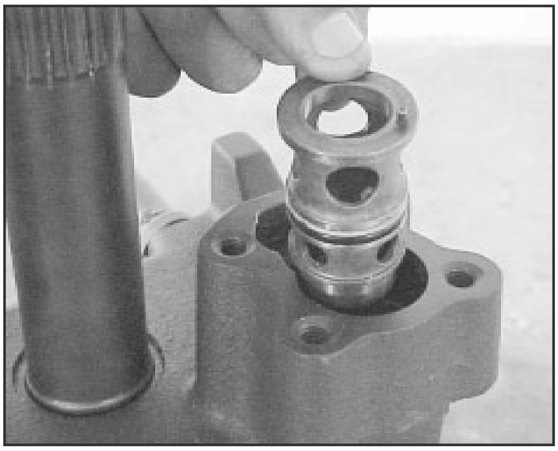
35. Remove the seal and discard it (fig 74).



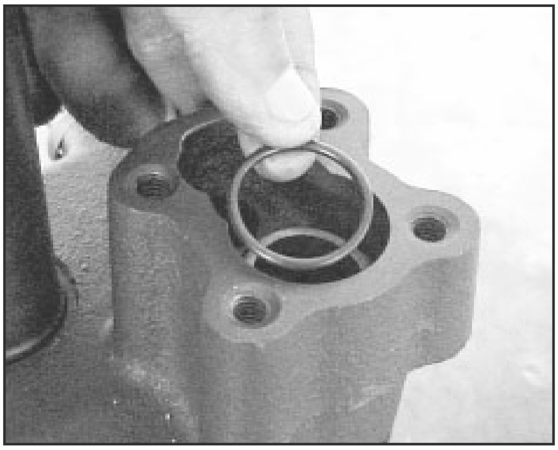
36. Remove valve spring retainer clip, slide it into position to hold back the spring tension. Remove and discard the retaining ring (fig 75)



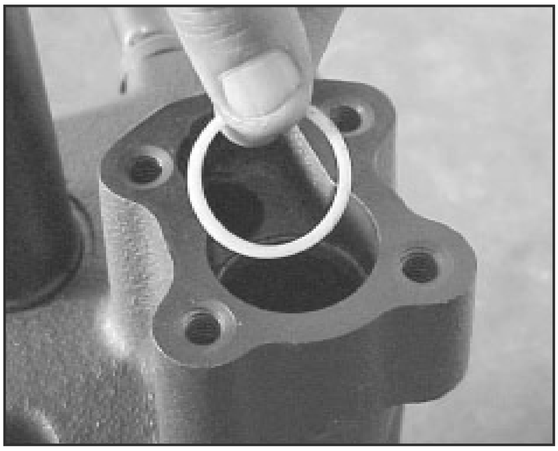
37. Withdraw the control valve (fig 76).



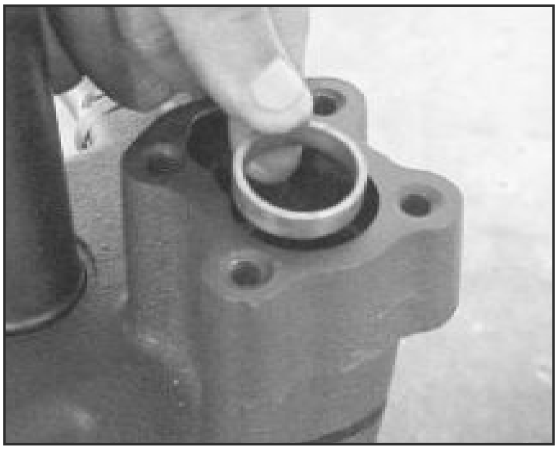
38. Withdraw the sleeve (fig 77).



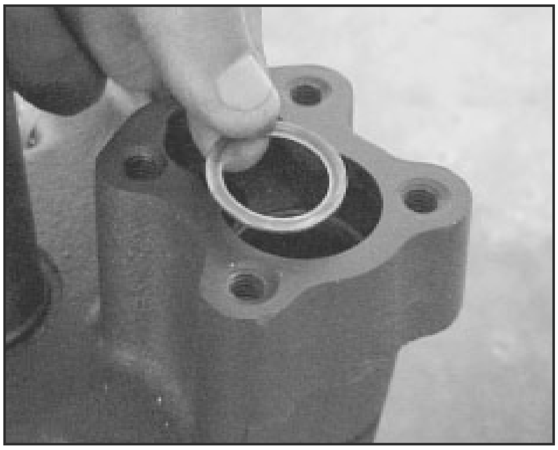
39 . Remove the “O” ring (fig 78).



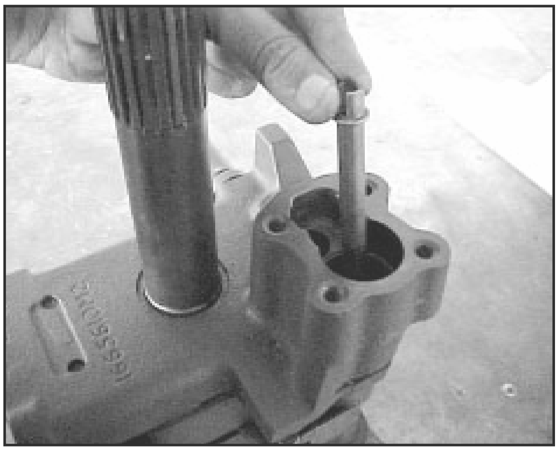
40. Remove the backup washer (fig 79).



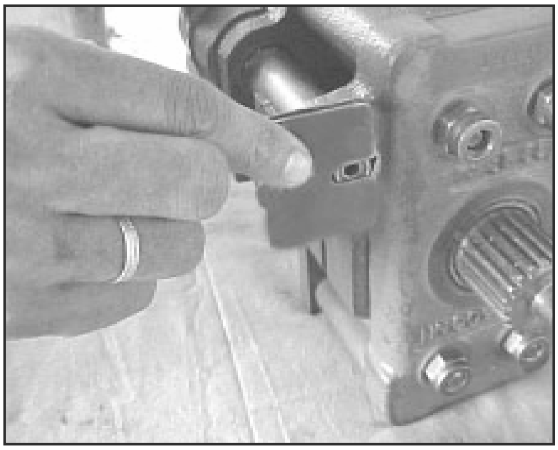
41. Remove the spacer (fig 80).



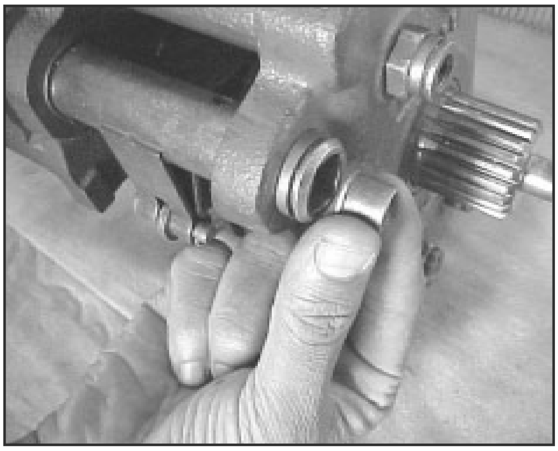
42. Remove the washer (fig 81).



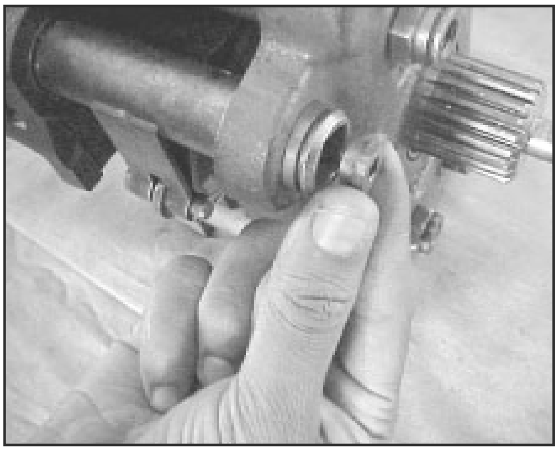
43. Remove the balancer tube (fig 82).



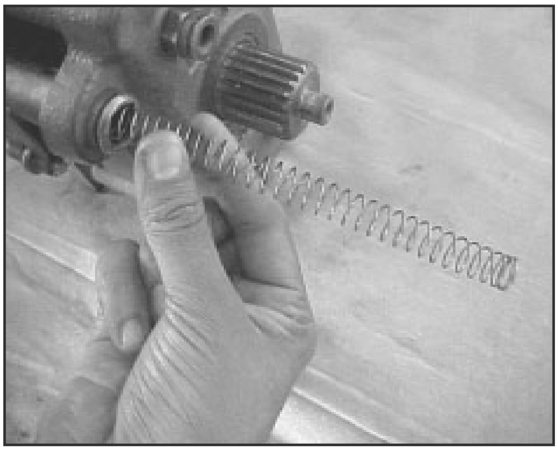
44. Remove Special Tool MF352, take care that the spring is not ejected (fig 83).



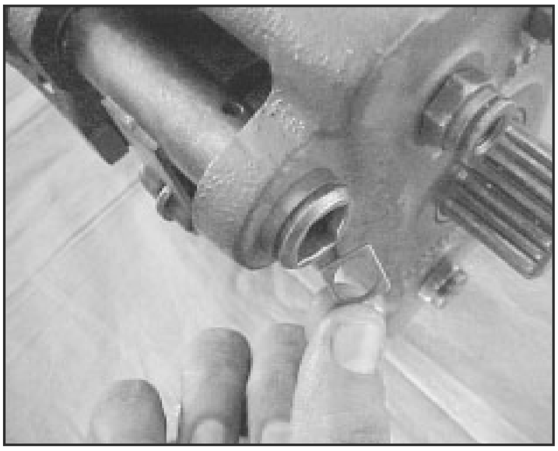
45. Remove the collar (fig 84).



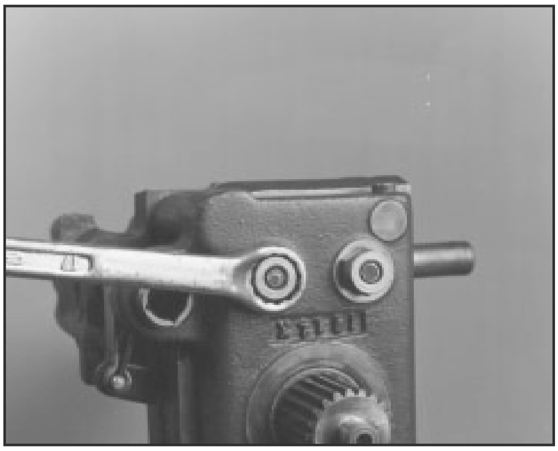
46. Remove the guide (fig 85).



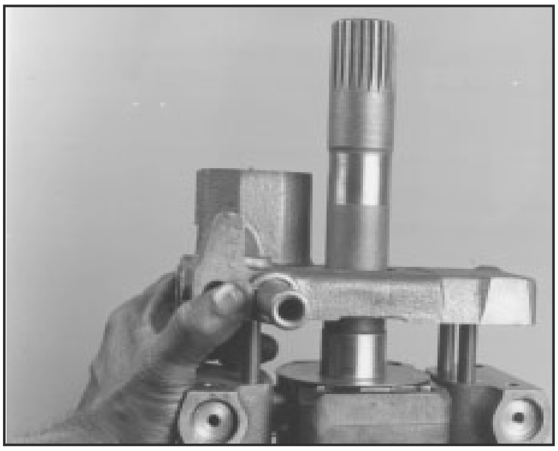
47. Remove the spring (fig 86).



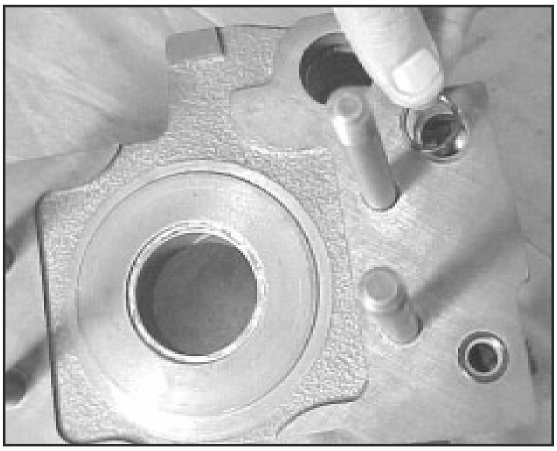
48. Remove the square disc (fig 87).



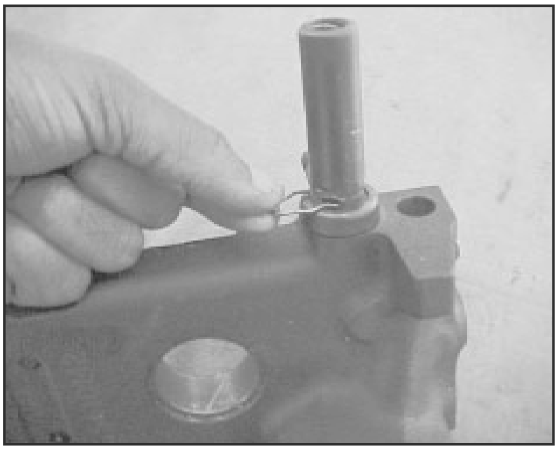
49. Remove the four main pump body nuts (fig 88). **(17 mm)**



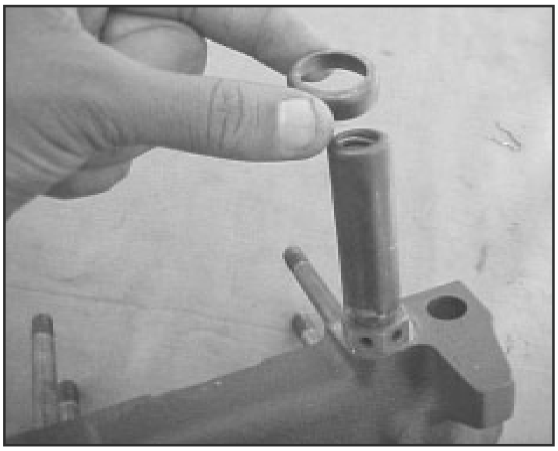
50. Detach the rear body (fig 89).



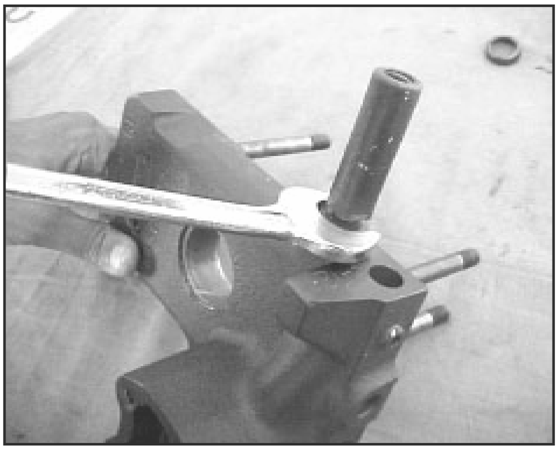
51. Remove and discard the ‘O’ rings (fig 90).



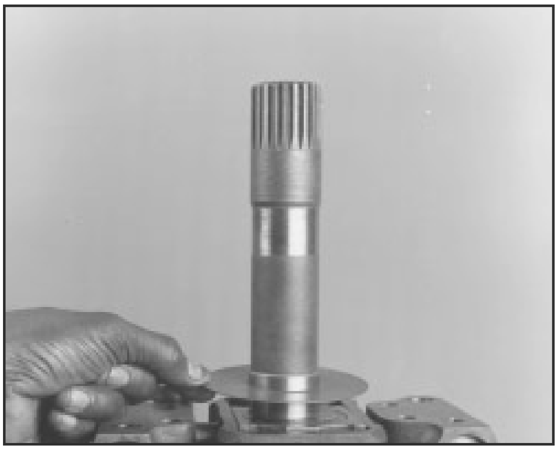
52. Remove the lock pin (fig 91).



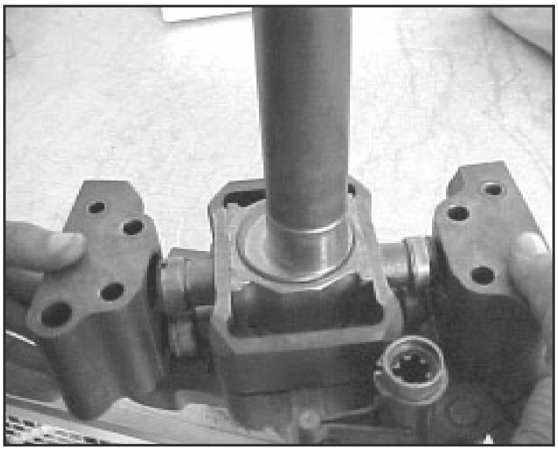
53. Remove the sleeve (fig 92).



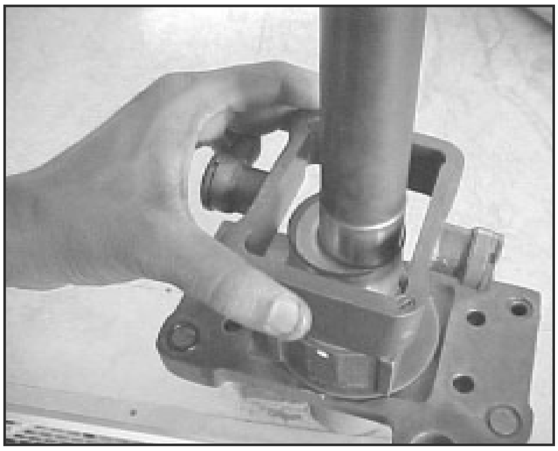
54. Remove the relief valve (fig 93). **(19 mm)**



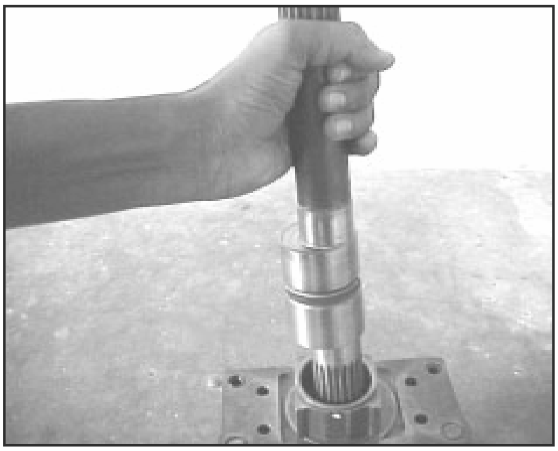
55. Remove the thrust washer (fig 94).



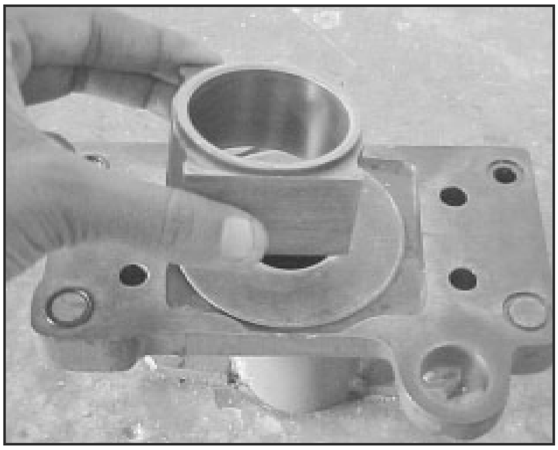
56. Withdraw the two valve chambers from the front body (fig 95).



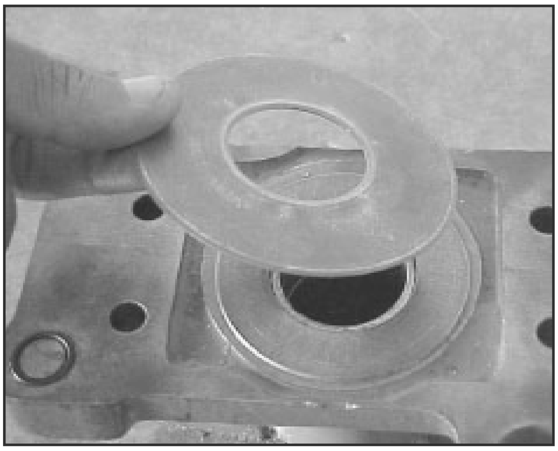
60. Remove the rear piston assembly (fig 96).



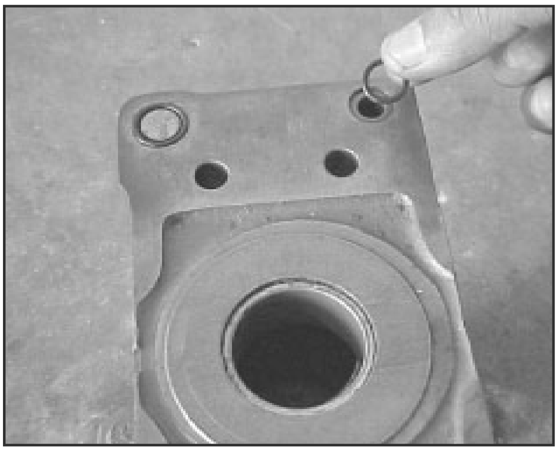
61. Remove the cam shaft (fig 97).



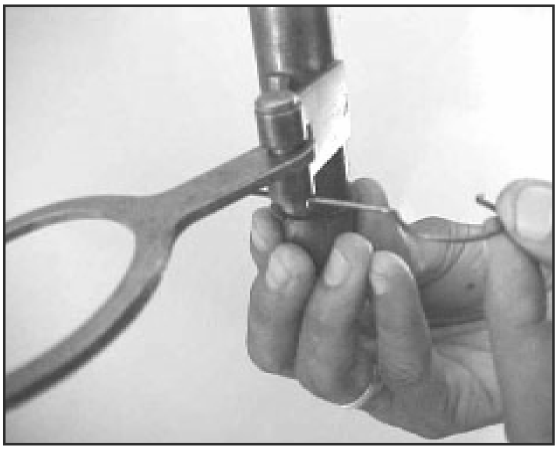
62. Remove the rear cam block (fig 98).



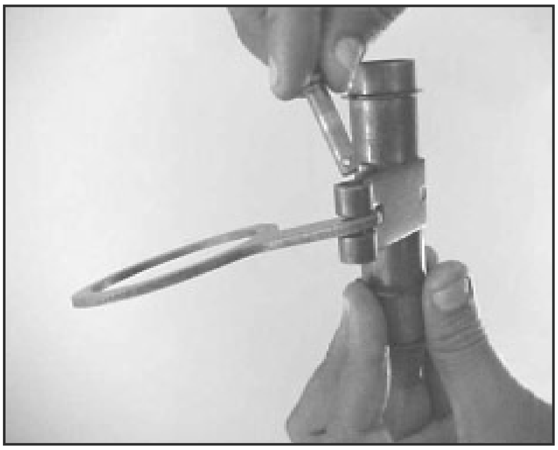
63. Remove the rear thrust washer (fig 99)



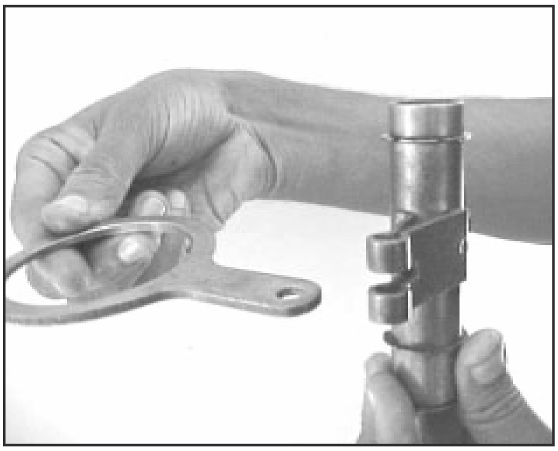
64. Remove the “O” rings from front and rear body (fig 100)



65. Remove the pin and retainer clip (fig 101).

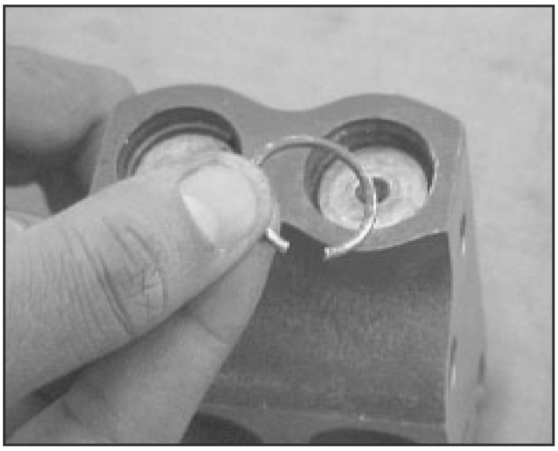


66. Remove the pin (fig 102).



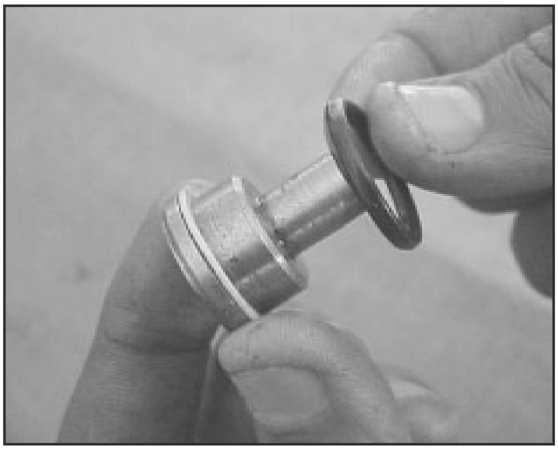
67. Remove the cam follower from the oscillator tube (fig 103)

VALVE CHAMBER

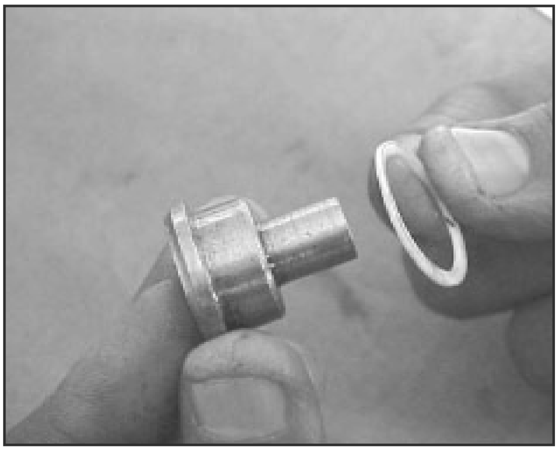


68. Remove and discard the circlip (fig 104).

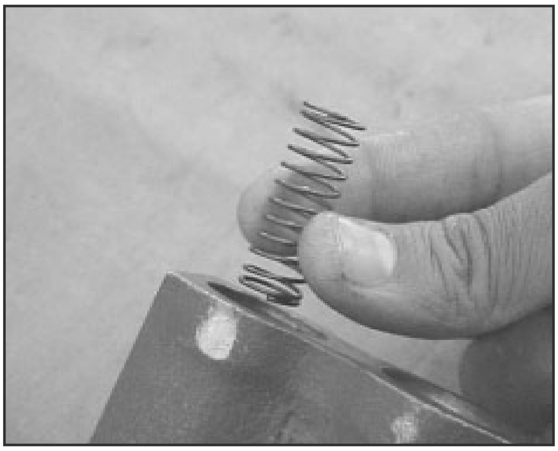
69. Remove valve chamber plug out of the housing (fig 105).



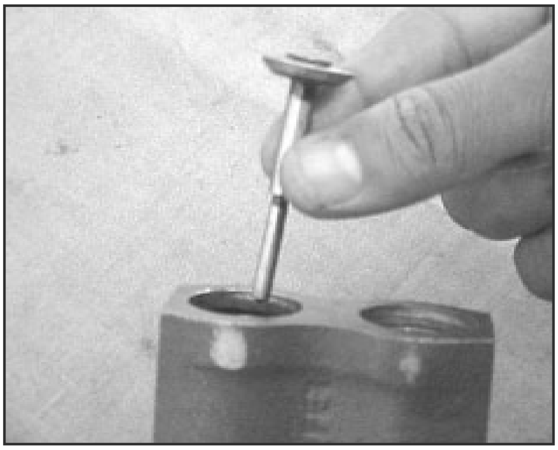
70. Remove and discard the “O” ring (fig 106).



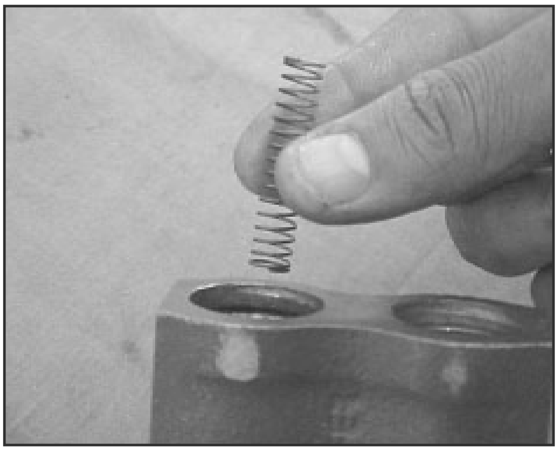
71. Remove and discard the backup washer (fig 107).



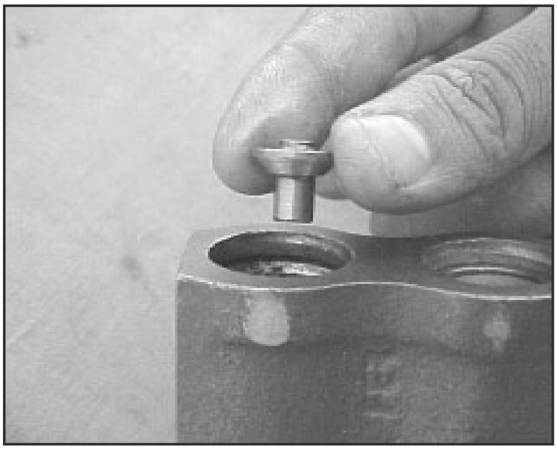
72. Remove the spring (fig 108).



73. Remove the valve (fig 109).



74. Remove the spring (fig 110).



75. Remove the inlet valve (fig 111).

76. Repeat procedure 66 to 73 for the other three valves.

Examination

Check the condition of all components for wear or damage. Replace any defective components. Always replace "O" rings, back-up washer, gaskets and circlips. Lubricate the "O" rings with oil before fitting.

Assembly

Reverse the above procedure for assembly.

77. If necessary, form new valve seats, using MF.349 valve seat cutter and forming tool in the following sequence:

78. Carry out the following:

a. Cut the top seat in the valve chamber using the large end of the cutter and tommy bar provided.

b. When satisfactory seat has been formed remove the tool and fit the sleeve to the small end of the cutter.

c. Insert the small end and carefully rotate the cutter to remove the burr around the top seat.

d. Remove the cutter and sleeve, re-insert and cut the bottom seat until a satisfactory result has been obtained. The cutter has been designed to ensure the correct depth of the bottom seat.

HYDRAULIC RELIEF VALVE

Removal and refitment

The relief valve is non-adjustable, and in the event of failure must be replaced by a new unit. It is identified by a black paint stripe on the outer tube of the relief valve assembly . The pressure of the new valve remains unchanged at 190 - 225 kg/cm^2 (2702 - 3200 psi).

Removal

1. Remove the right-hand side cover, see operation 11A . 15.
2. Remove the spring clip.
3. Remove the shield.
4. Unscrew the relief valve.

Refitment

5. Reverse procedure 1 to 4 except:
   a. Tighten the relief valve to a torque of 18.5 lbf.ft (25 Nm).
   b. Ensure that the shroud is held down so as to cover the hexagon part of the valve.

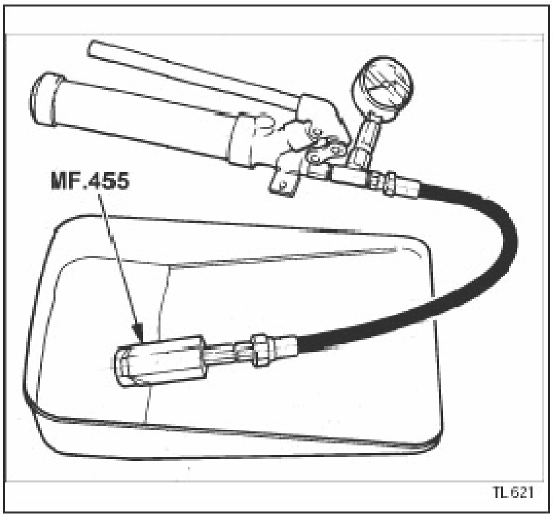


Fig 112

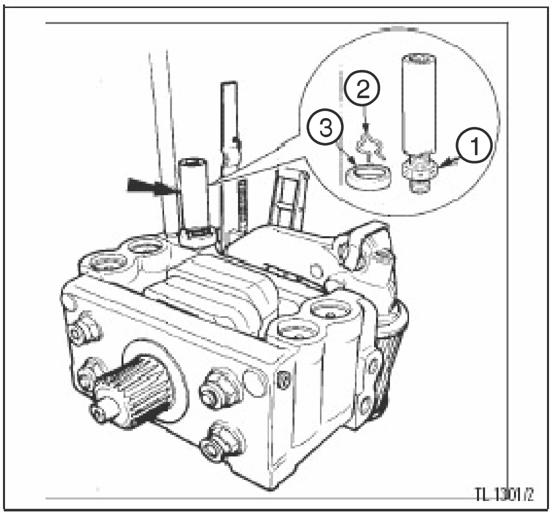


Fig 113

11 A . 15 RIGHT-HAND SIDE COVER

Removal and refitment

Removal

1. Drain the transmission oil to the LOW mark on the dipstick.
2. Remove the brake actuator if necessary.
3. Remove the dipstick.
4. Disconnect the Response Control rod.
5. Remove the right-hand side cover.
6. Remove and discard the gasket.

Refitment

7. Reverse procedures 1 to 8 except:
   a. Fit a new gasket.
   b. Locate the Response Control levers to the hydraulic pump.
   c. Seal the six bolts with Hylomar sealant.

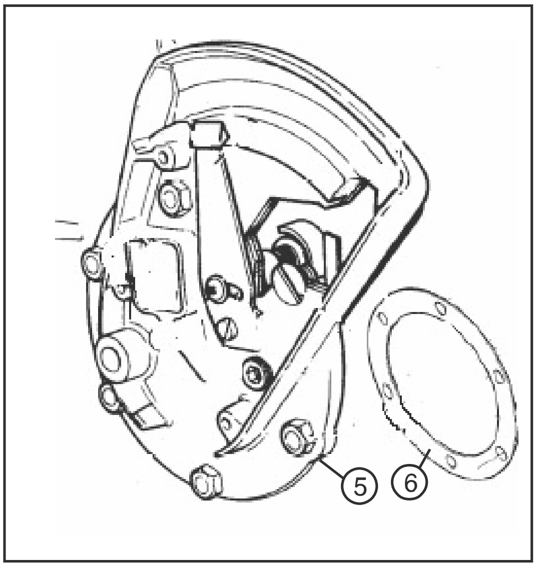


Fig 114

11A . 16 RIGHT-HAND SIDE COVER

Overhaul

Dis-assembly

1. Remove the right-hand side cover. See operation 11A . 15.
2. Remove the screw lever retaining.
3. Remove the flat washer.
4. Remove the response lever.
5. Remove pin spirol.
6. Remove the cam.
7. Remove the spring.
8. Remove the ring.
9. Remove the ‘O’ ring.
10. Remove the shaft.
11. Remove the pin spirol.
12. Remove the plate lever adjusting.

Re-assembly

13. Reverse procedures 1 to 12 except:
    a. Fit new ‘O’ rings.
    b. Fit new roll pins.
    c. Adjust the Response Control

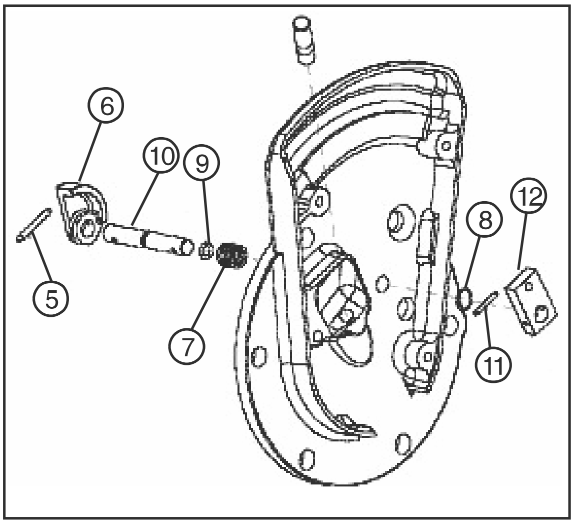


Fig 115

11A . 17HYDRAULIC PUMP OIL STRAINER

Servicing

Procedure

1. Drain the oil.
2. Remove the three bolts and washers securing the cover plate to the bottom of the centre housing.
3. Remove the cover plate.
4. Remove and discard the gasket.
5. Remove the clip.
6. Remove the nut.
7. Remove the spring.
8. Remove the washer.
9. Remove the ‘O’ ring.
10. Pull out the strainer.
11. Thoroughly clean the strainer in cleaning solvent and / or replace.
12. Re-assemble by reversing procedures 1 to 9 except:
    a. Fit new ‘O’ ring.
    b. Fit new cover plate gasket.

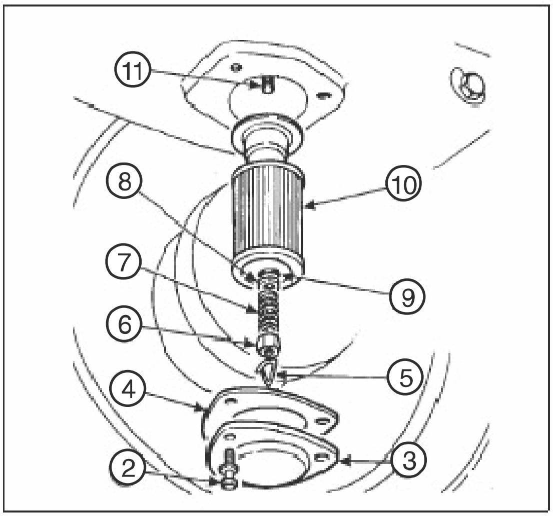


Fig 116

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SECTION 11

AUXILIARY HYDRAULICS

AUXILIARY HYDRAULICS

Table of Contents

Operation No.	Description		Page No.
11B . 1	Specification	...	11B - 3
11B . 2	General description	...	11B - 5
11B . 3	Control valve assembly - removal	...	11B - 6
11B . 4	Control valve section - removal	...	11B - 6
11B . 5	Auxiliary pump flow and pressure test - check	...	11B - 7
11B . 6	Auxiliary pump and plated drive - removal	...	11B - 8
11B . 7	Auxiliary hydraulic pump - overhaul	...	11B - 9
11B . 8	Plated drive - overhaul	...	11B - 11
11B . 9	Hydraulic lift and auxiliary pump filter - servicing	...	11B - 12

11B . 1 SPECIFICATION:

Auxiliary pump type	:	Gear type 10 X 4 with two sections for auxiliary hydraulics and IPTO
Pump output:		
Auxiliary	:	9.77 gpm (37 lpm)
I.P.T.O.	:	5.12 gpm (19.4 lpm)
Relief valve setting at 2000 engine rev/min:		
Auxiliary	:	175 bar (2538 psi)
I.P.T.O	:	60 bar (870 psi)
Filter	:	140 micron serving lift pump and auxiliary pump - Washable
Auxiliary pump drive	:	Plated drive gear train from lift pump.
Auxiliary control valves		
Make	:	REXROTH (BOSCH)
Types	:	Open centre three position, spring return to neutral (Both position) , proportional spool type sectional valve
Number of Sections	:	1 or 2
Flow at quick release coupling at 2000 engine rev/min at 124 bar:		
Auxiliary pump	:	9.51 gpm (36.0 lpm)
Pressure at Quick Release Couplings at 2000 engine rev/min:		
Auxiliary pump	:	170 - 190 bar (2466 - 2756 psi)
Special tools		
MF.3001	:	Pressure Test Kit
MF.3002	:	Hose Kit
MF.3003	:	Hydraulic Flow Meter
Bolt torques:		
Control valve stud nuts	:	13 lbf.ft (18 Nm)
Plated drive to pump bolts	:	21 lbf.ft (30 Nm)
Plated drive spacer nuts	:	20 lbf.ft (27 Nm)
Plated drive socket head screw	:	20 lbf.ft (27 Nm)
Pump relief valve	:	37 lbf.ft (50 Nm)
Pump end cover bolts	:	33 lbf.ft (45 Nm)

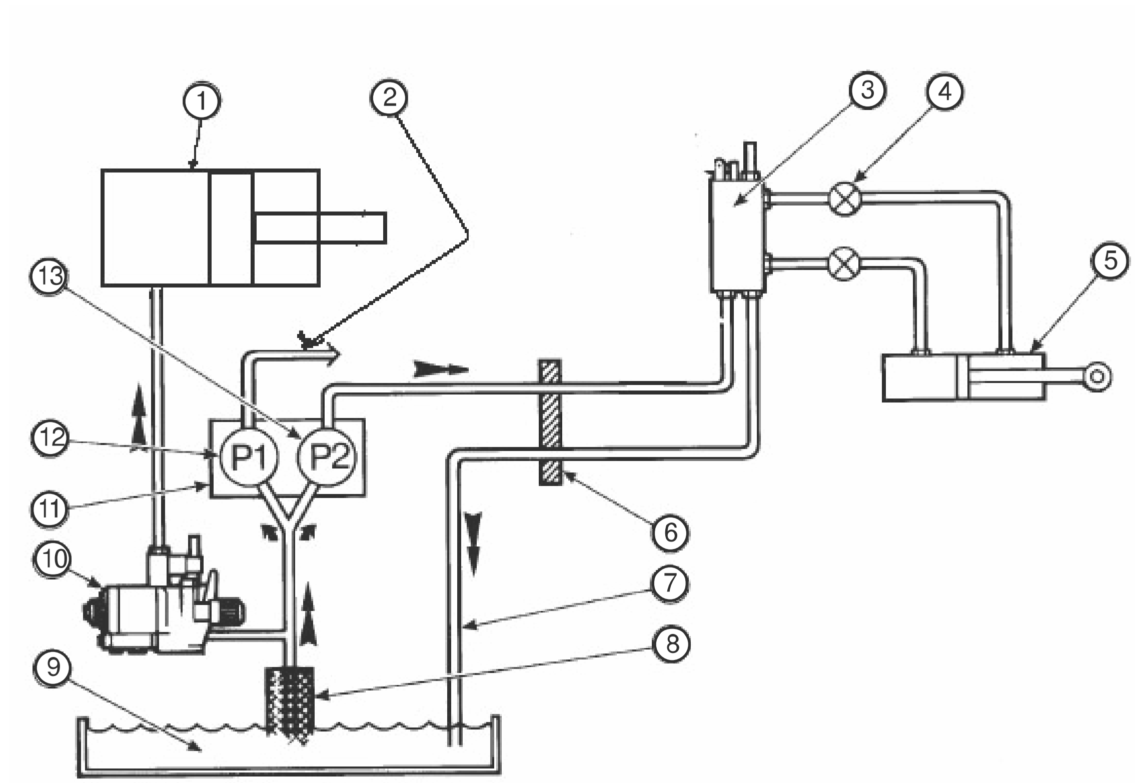


Fig 1

1.	Ram cylinder.	8.	Suction strainer.
2.	Supply to IPTO clutch.	9.	Transmission oil.
3.	Hydraulic control valve.	10.	Ferguson lift pump.
4.	Quick release coupling.	11.	Dual element pump.
5.	External hydraulic cylinder.	12.	P1 - IPTO section.
6.	Left-hand side cover.	13.	P2 - Auxiliary section.
7.	Return to transmission.		

11B . 2 GENERAL DESCRIPTION :-

The auxiliary hydraulic system is in two parts and is powered by a dual element auxiliary hydraulic pump driven from a plated drive in front of the hydraulic lift pump. The pump draws its oil through a special 140 micron filter attached to the lift pump and delivers oil at 9.77 gpm (37 lpm) to the auxiliary control valve. The second section supplies oil to the Independent Power Take-Off (IPTO) clutch at 5.124 gpm (19.4 lpm).

Auxiliary hydraulics

The oil supply from the pump is taken through the left-hand side cover to the auxiliary hydraulic control valve mounted behind the seat. This valve can be in either one or two sections . The following specification of control valve is available:

1. Three position, spring return to neutral.
2. Open centre three position, spring return to neutral (Both position) , proportional spool type sectional valve

A check valve is provided within the valve on the pressure side (pump side) which will not open until the pump pressure is greater than the pressure in the ram. This prevents the external ram from dropping before lifting. It also prevents the ram from dropping if the control valve is moved to the lift position when the engine is stopped. Oil from the control valve is conveyed to a series of quick release couplings at the rear of the tractor. Return oil from the control valve is returned through the left-hand side cover back to the transmission.

The operating pressure of 170 - 190 bar (2466 - 2756 psi) is controlled by a pressure relief valve built into the hydraulic pump.

11B . 3 CONTROL VALVE ASSEMBLY

Removal and refitment

Removal

1. Disconnect the feed, return outlet pipes and links from the control valve.
2. Remove the four attachment bolts, and lift off the control valve assembly.

Refitment

3. Reverse procedures 1 and 2

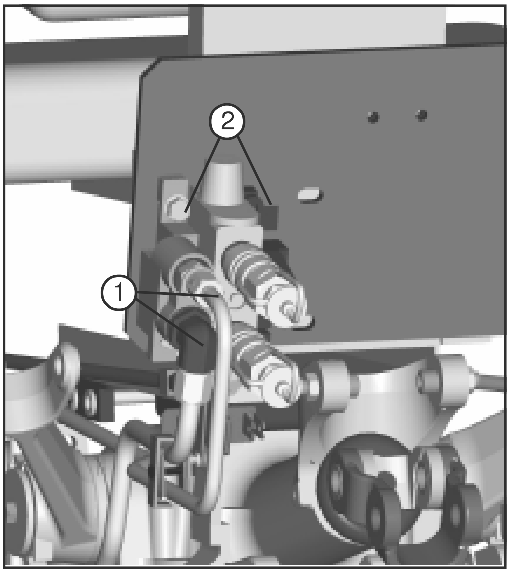


Fig 2

11B . 4 CONTROL VALVE SECTION

Removal and refitment

Removal

1. Remove the control valve unit from the tractor, see operation 11B . 3
2. Remove the four nuts and studs securing the control valve sections.
3. Remove the end plates, sectional valves, intermediate plates.
4. Remove the ‘O’ rings.
5. Thoroughly clean the mating faces of the control valve sections and end plates.

Refitment

6. Fit new ‘O’ rings to the recesses in the control valve sections.
7. Place the control valve sections on a flat surface with the feed ports up.
8. Align the valve sections and refit the studs, nuts and lockwashers.
9. Re-tighten the nuts to a torque of 13 lbf.ft (18 Nm).

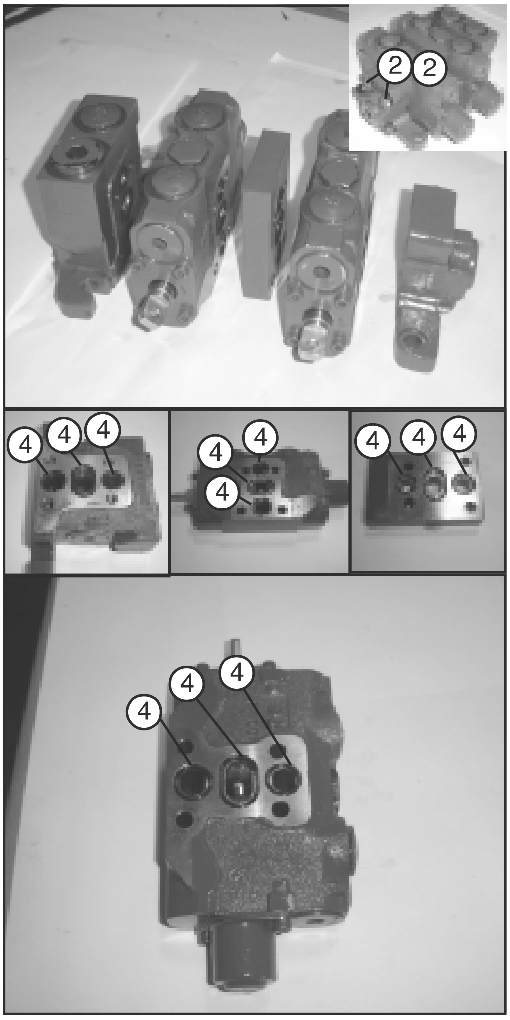


Fig 3

11B . 5 AUXILIARY PUMP FLOW AND PRESSURE TEST

Check

Special Tools:

MF3001	Pressure test kit
MF3002	Hose kit
MF3003	Hydraulic flow meter

Procedure

1. Connect the two hoses from the MF.3002 hose kit to the MF.3003 Flow Meter. Fit to each end of the hoses a quick release coupling that will fit the connections on the rear of the tractor.
2. Fit the flow meter inlet hose to the No. 1 coupler at the rear of the tractor.
3. Fit the outlet hose to the No. 2 coupler.
4. Connect the 300 bar (4351 psi) gauge in the MF.3001 pressure test kit to the test point on the flow meter.
5. Fully OPEN the flowmeter restrictor valve.
6. Start up the engine and warm-up the hydraulic system. The oil temperature must be 122 - 140°F (50-60 °C).
7. Set the engine speed to 2000 rev/min.
8. Move the control valve lever serving couplers numbers 1 and 2 rearwards and hold in this position.
9. Slowly screw-in fully the restrictor valve on the flow meter.
10. The pressure reading should be 170-190 bar (2466 - 2756 psi). The flow meter should read 9.510 gpm (36 lpm). Minimum accepted flow 8.453 gpm (32 lpm).

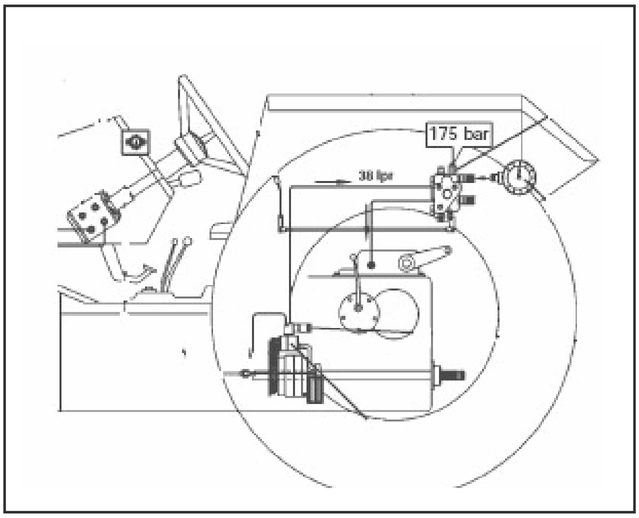


Fig 4

Diagnosis:

S.No.	Symptom - Auxiliary pump flow or pressure low	
	Cause	Action
1	Auxiliary pump worn	Replace pump or repair
2	Pressure relief valve faulty	Replace valve and reset
3	Control valve faulty	Overhaul valve
4	Quick release coulings blocked	Replace couplings
5	Suction strainer blocked	Clean strainer
6	Insufficient oil in transmission	Fill to level

11B . 6 AUXILIARY PUMP AND PLATED DRIVE

Removal and refitment

Removal

1. Remove the lift cover, see operation 11A . 5
2. Drain the transmission oil.
3. Split the tractor between the gearbox and spacer or centre housing, see operation 4A . 4
4. Disconnect the flexible pipe supplying the IPTO clutch.
5. Disconnect the pipe to the side cover.
6. Disconnect the pipe at the side cover and remove.
7. Remove the hydraulic lift and auxiliary pump filter.
8. Remove the two nuts and the dowel pins each side of the transmission case holding the lift pump.
9. Withdraw the hydraulic lift pump complete with plated drive and auxiliary pump from the front of the centre housing.

Auxiliary Pump

10. Place the lift pump, plated drive and auxiliary pump assembly on a bench, remove the external circlip holding the pump gear in place.
11. Remove the socket head setscrew.
12. Remove the two bolts and spacers.
13. Remove the auxiliary pump.
14. Remove the elbow between the auxiliary pump and the filter manifold.
15. Remove the auxiliary pump drive gear.

Plated Drive

16. Remove the two external retaining clip holding the plated drive to the hydraulic lift pump.
17. Withdraw the drive off the pump drive shaft.

Re-assembly

18. Reverse procedures 1 to 17 except:
    - (a) Do not forget the elbow between the auxiliary pump and the filter manifold.
    - (b) Tighten the two bolts and spacers to a torque of 21 lbf.ft (30 Nm), plated drive to pump.
    - (c) Tighten the socket head cap screw to a torque of 20 lbf.ft (27 Nm), plated drive to pump.
    - (d) Check the total backlash between the three gears, it must be between 0.0019 inch (0.05 mm) and 0.0161 inch (0.41 mm).
    - (e) Refit the two external retaining clip holding the plated drive to the bottom left and top right nuts on the lift pump body.
    - (f) Do not forget that the right hand dowel pin (8) is a tight fit while the left hand is an easy fit.

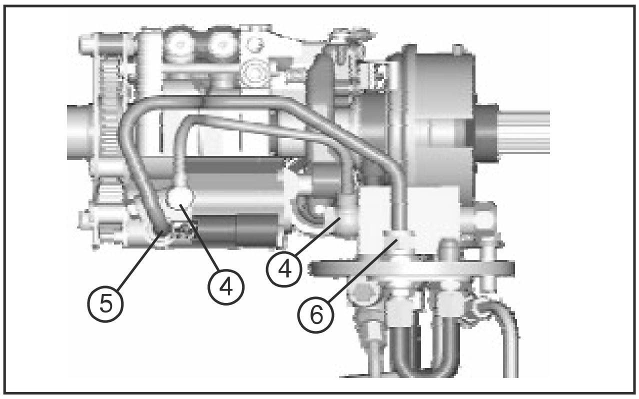


Fig 5

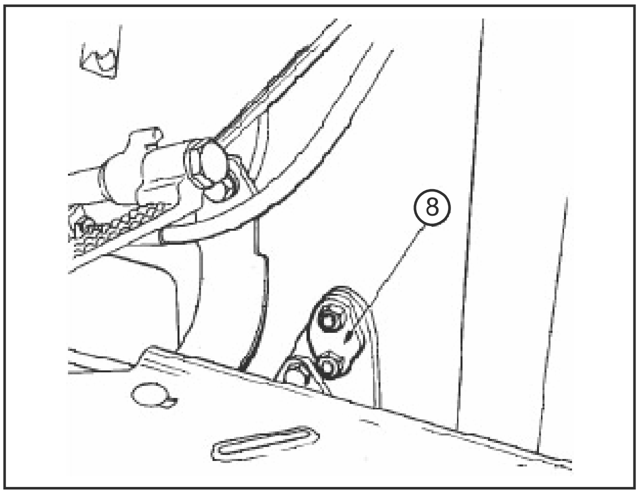


Fig 6

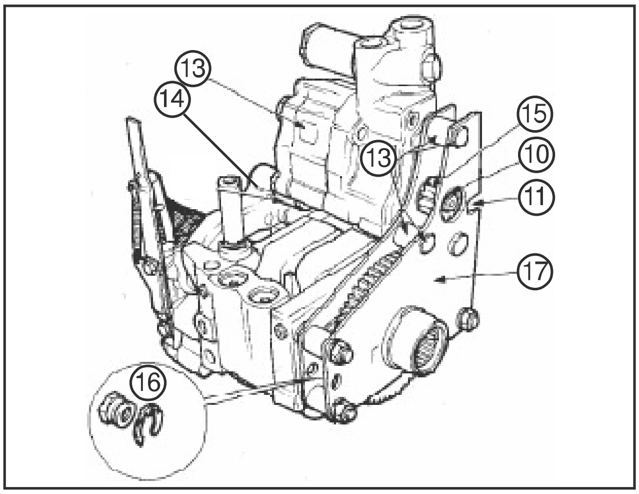


Fig 7

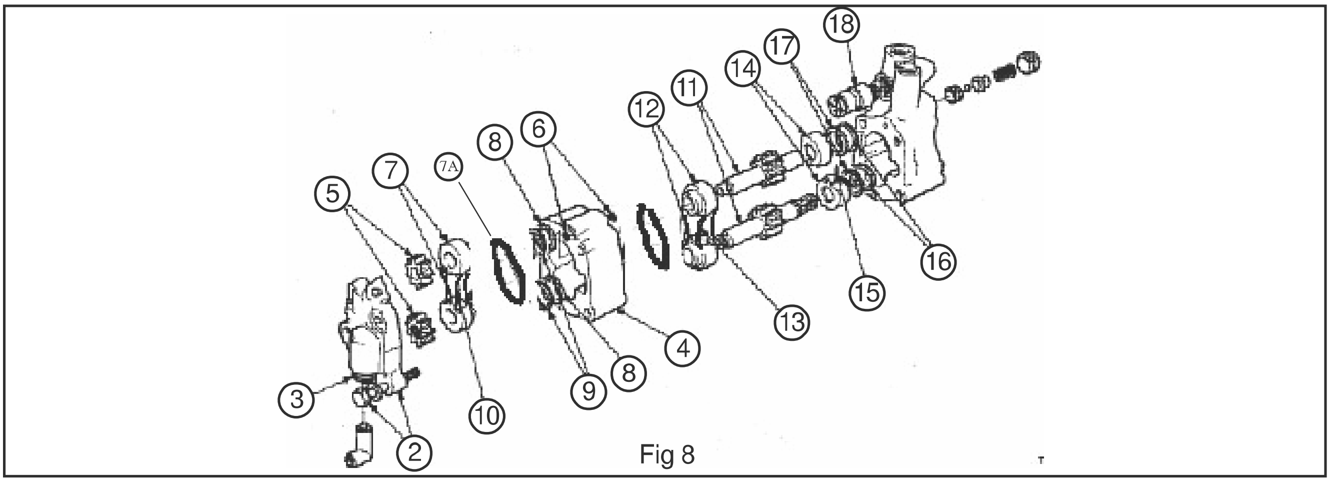


Fig 8

11B . 7 AUXILIARY HYDRAULIC PUMP

Overhaul

Dis-assembly

1. Remove the auxiliary pump, see operation 11B . 6.
2. Remove the four securing bolts and remove the end cover.
3. Remove the 'O' ring.
4. Withdraw the centre body section complete with gears off the drive shafts.
5. Remove the gears.
6. Remove the two 'O' rings.
7. Carefully, with finger pressure only, remove the centre section bearings, mark their position with a felt tip pen so they can be refitted in the original position.

7A. Remove the 'O' ring

8. Remove the seal support rings.
9. Remove the seals.
10. Separate the centre section bearings and remove the dowel pin.
11. Withdraw both shafts complete with bearings from the front body. DO NOT USE FORCE. Mark the bearings with a felt tip pen for refitment.
12. Remove the centre section bearings from the shafts.
13. Separate the bearings and remove the dowel pin.
14. Remove the bearings from the front body, see procedure 7.
15. Separate the bearings and remove the dowel pin.
16. Remove the seal support washers.
17. Remove the seals.
18. Remove the main relief valve, if necessary.

Examination

Bearings

Examine the bearings for wear on their faces and in their bores. During a major overhaul the bearings should be renewed, but if not badly worn they can be salvaged as follows:

Place a sheet of '0' grade emery paper, lubricated with paraffin on a true flat surface, e.g. a surface plate, or plate glass, then polish the bearing face, using a light rotary motion.

Bodies

Inspect the front and centre bodies for external damage and cracks. Examine the bodies for wear and damage. The gears will always cut a light track on the inlet side of the body bores. The depth of this track must not exceed 0.00019 inch (0,005 mm). The depth of the track can be very difficult to measure with such accuracy. If in doubt replace the body.

Gears

Examine the gears for scored or worn faces or journals, damaged teeth and surface cracks. Always fit replacement gears as a pair and never individually.

Bearing Seals and 'O' Rings .

Always fit new seals and 'O' rings on re-assembly.

Relief Valves

The two pressure relief valves are factory preset units, if the valve is suspect it is recommended that the entire unit be replaced.

Re-assembly:

19. Reverse procedure 1 to 18 except:

    (a) Retighten the main relief valve to a torque of 37 lbf.ft (50 Nm).

    (b) When rebuilding the pump DO NOT use unnecessary force, e.g. a hammer and drift. Using hand pressure only, gently ease the bearings into the bores until they have seated onto their seals.

    (c) When replacing the front body bearings ensure that the uppermost bearing is fitted with its relieved face adjacent to the outlet port.

    (d Measure the protrusion of the bearings above the joint face of the body. This dimension must lie between 0 - 0.0196 inch (0-0.5 mm) MAXIMUM. If the dimension falls below zero and the bearings become recessed renew the seals. If this dimension is above 0.0118 inch (0.3 mm) then the bearings have not seated correctly because of a slight seizure in the bores.

    (e Measure the protrusion of the gear wheels from the centre body face. If the protrusion is not correct take action as detailed in the above paragraph.

    (f) Retighten the end cover bolts to a torque of 33 lbf.ft (45 Nm).

    (g) The drive shaft will be difficult to turn by hand when the pump is re-assembled. This condition is quite normal. Check for rotation by temporarily assembling a drive gear to the shaft and turn using a cloth wrapped around the gear.

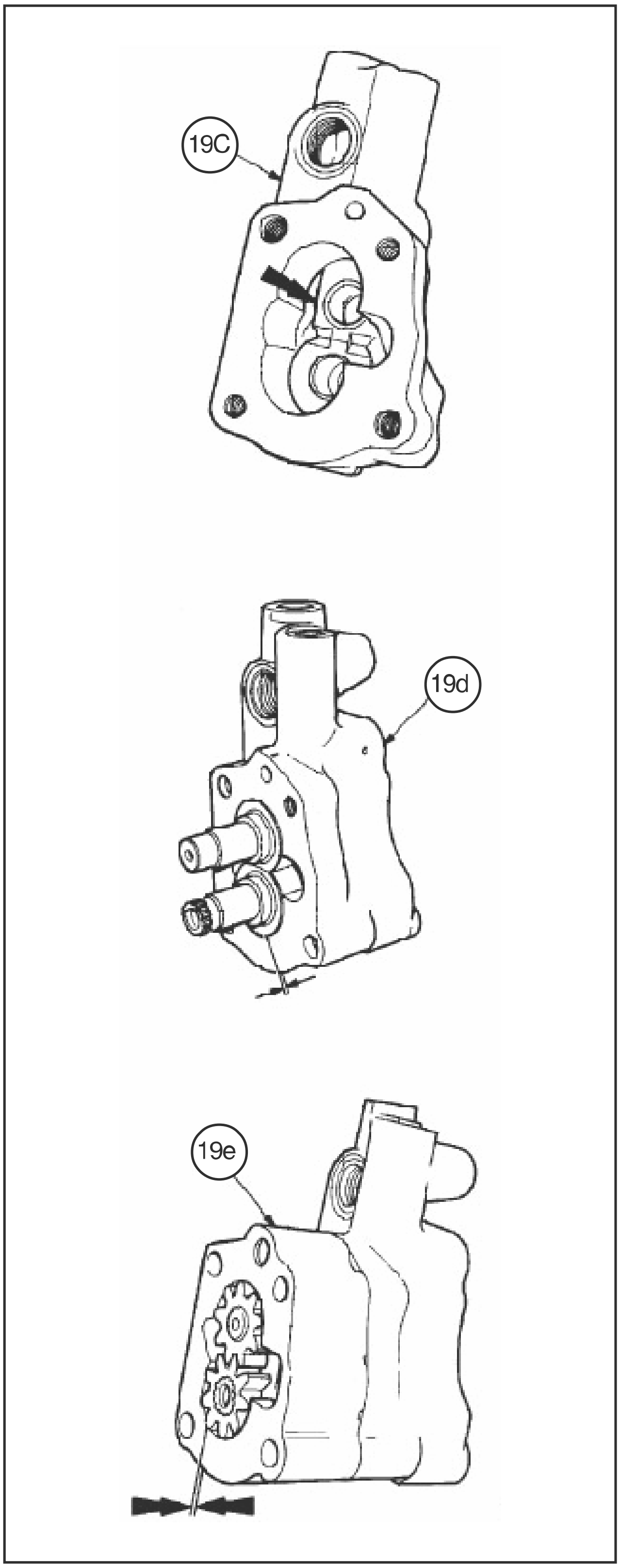


Fig 9

11B . 8 PLATED DRIVE

Overhaul

Dis-assembly

1. Remove the plated drive, see operation 11B . 6.
2. Remove the nuts and washers.
3. Remove the plate and spacers.
4. Lift out the drive gear and bushes.
5. Remove the idler gear, thrust washers and needle rollers.
6. Push the idler shaft complete with its circlip out of the side plate.

Examination

Check the gear teeth for wear, chipping, or other damage. Examine the bores of the gears, bushes and needle rollers for wear. Check the idler shaft and thrust washers for wear, scoring, or pitting.

Replace any defective components.

Re-assembly

7. Refit the idler shaft to the rear plate complete with circlip.
8. Fit a thrust washer to the idler shaft.
9. Replace the 22 rollers inside the idler gear using petroleum jelly; fit the gear and second thrust washer.
10. Refit the drive gear and bushes, ensure that the flats on the bush locate against the lugs on the plates to prevent rotation.
11. Refit the spacers, plate and nuts. Tighten the nuts progressively to 20 lbf.ft (27 Nm).
12. Refit the lift pump, plated drive and auxiliary pump assembly, see operation 11B . 6.

    Check that the flat on the end of the idler gear shaft locates correctly to the bottom of the auxiliary pump.

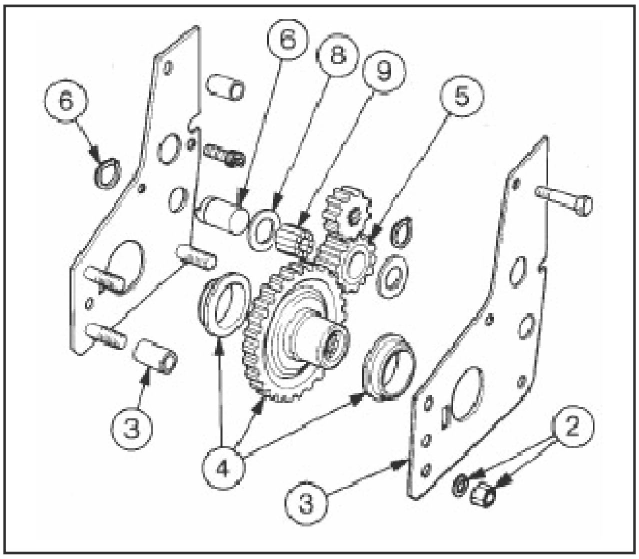


Fig 10

11B . 9 HYDRAULIC LIFT AND AUXILIARY PUMP FILTER

Servicing

Procedure

Procedure

1. Drain the oil.
2. Remove the three bolts and washers securing the cover plate to the bottom of the centre housing.
3. Remove the cover plate.
4. Remove and discard the gasket.
5. Remove the clip.
6. Remove the nut.
7. Remove the spring.
8. Remove the washer.
9. Remove the 'O' ring.
10. Pull out the strainer.
11. Thoroughly clean the strainer in cleaning solvent and / or replace.
12. Re-assemble by reversing procedures 1 to 9 except:
    (a). Fit new 'O' ring.
    (b). Fit new cover plate gasket.

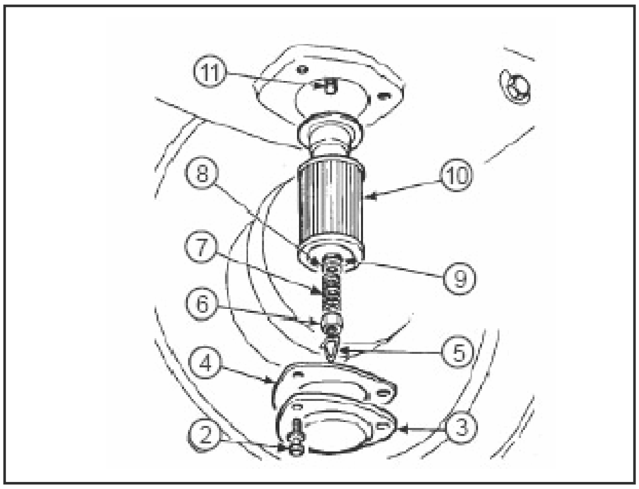


Fig 11

SECTION 12

PART A

12A - 1. LIVE POWER TAKE-OFF

Part A

LIVE POWER TAKE OFF
Table of Contents

Operation No.	Description	Page No.
12A.1	Specification … …	12A - 3
12A.2	Left hand side cover - Removal … …	12A - 5
12A.3	Left hand side cover - over haul … …	12A - 5
12A.4	PTO shaft , Bearing and oil seal removal …	12A - 6

12A . 1SPECIFICATION

540 rev/min PTO speed - 1790 engine rev/min
Engine to PTO shaft ratio - 3.31 : 1 (16T drives 53T)
No. of splines - 6
Outside diameter - 1 3/8 inch (34.80 mm).

BOLT TORQUES

Nuts, rear seal retainer to centre housing – 83-125 lbf.ft (113-169 Nm).
Nuts, rear seal retainer to drawbar bracket – 170-192 lbf.ft (230-260 Nm).

SPECIAL TOOLS

SER / 046	Seal replacer

GENERAL

DESCRIPTION

Single Speed Power Take off (Fig.1)

540 rev/min live speed only.

The PTO shaft projects from the rear of the tractor. It is supported at the rear by a ball bearing and at the front by a needle roller bearing housed in the end of the hydraulic pump drive shaft. Splined onto the front end of the PTO shaft is a sliding gear which is operated by three position selector lever.

When the selector lever is moved rearwards the sliding gear moves forwards and the internal splines on the gear engage with the splines. on the hydraulic pump drive shaft. The PTO is then driven at a speed proportional to that of the engine, the standard shaft speed of 540 rev/min occurring at around 1790 engine rev/min for example.

When the selector lever is moved to the mid –position, the sliding gear moves to neutral and the PTO drive is disengaged.

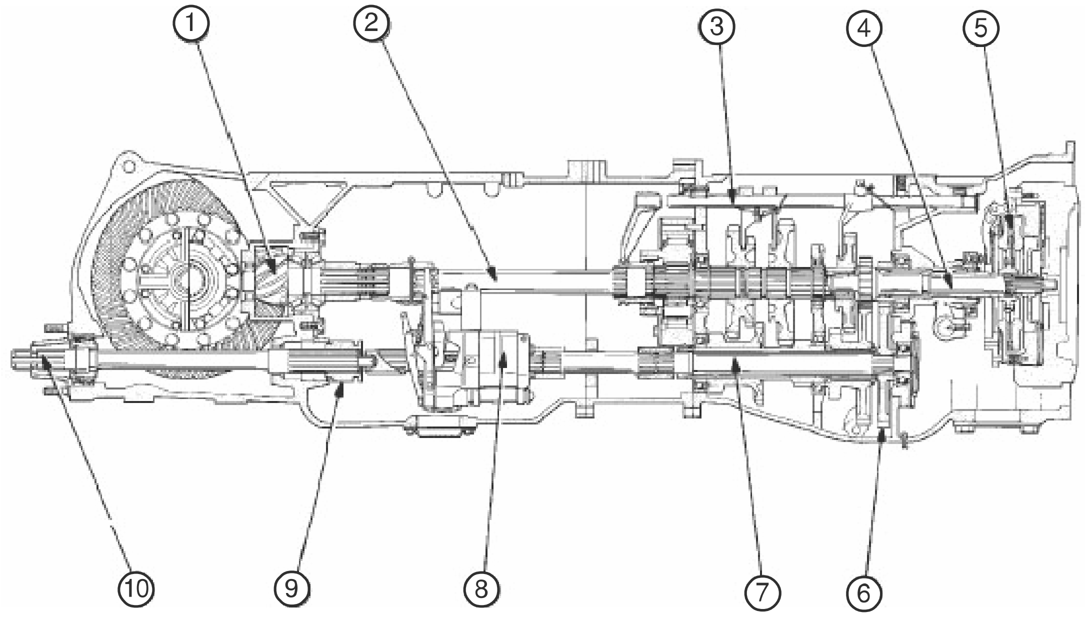


FIG-1. LIVE SPEED POWER TAKE-OFF

1.	Rear differential	6.	PTO contant mesh gears
2.	Drive shaft	7.	PTO layshaft
3.	Gear box	8.	Scotch yoke pump, Three point lift
4.	PTO input shaft	9.	Coupler
5.	PTO clutch plate	10.	PTO shaft (540 rev/min)

12A .2 LEFT-HAND PTO SIDE COVER

Removal and Refitment

Removal

1. Drain the transmission oil to the low mark on the dipstick.
2. Remove the auxiliary hydraulics pipelines from the side cover.
3. Disconnect the wires and remove the PTO neural safety switch.
4. Remove the six bolts.
5. Remove the side cover.
6. Remove and discard the gasket.

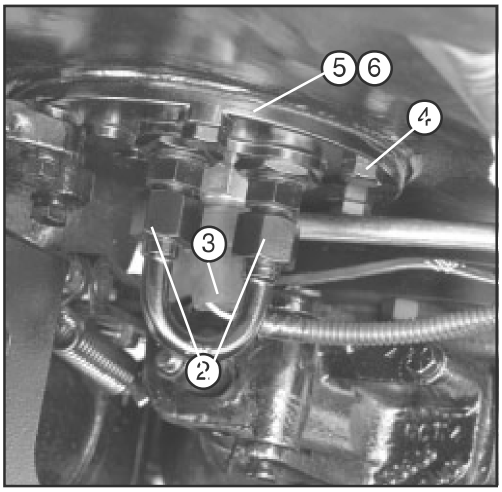


Fig 2

Refitment

7. Fit a new gasket.
8. Locate the shift lever into groove of the shift collar.
9. Seal the six bolts threads with Loctite and tighten the bolts.

12A . 3 LEFT-HAND PTO SIDE COVER

Overhaul

Diassembly

1. Remove the side cover. (Ref operation 12A.2)
2. Drive out and discard the roll pin.
3. Remove the PTO lever.
4. Remove the ring lock.
5. Remove the shift lever.
6. Remove and dicard the 'O'ring.
7. Remove the detent plunger and spring.

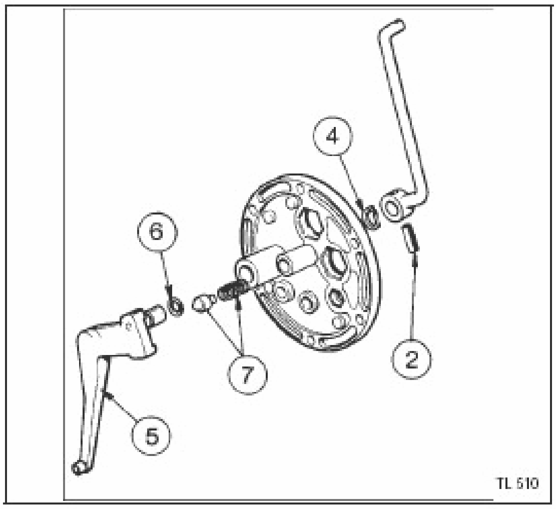


Fig 3

Reassembly

8. Reverse procedures 1 to 7 except:
    a. Fit a new 'O' ring.
    b. Fit a new roll pin.

12A - 4 PTO SHAFT, BEARING AND OIL SEAL

Removal and Refitment

Special Tools:

SER / 046 Seal Remover

Removal

1. Drain the transmission oil.
2. Unscrew the PTO cap.
3. Remove the 4 bolts from the cover and two centre bolts and washers. refer arrow
4. Remove the PTO oil seal housing.
5. Withdraw the shaft from rear axle.
6. Remove the snap ring.
7. Remove the bearing from the PTO shaft.

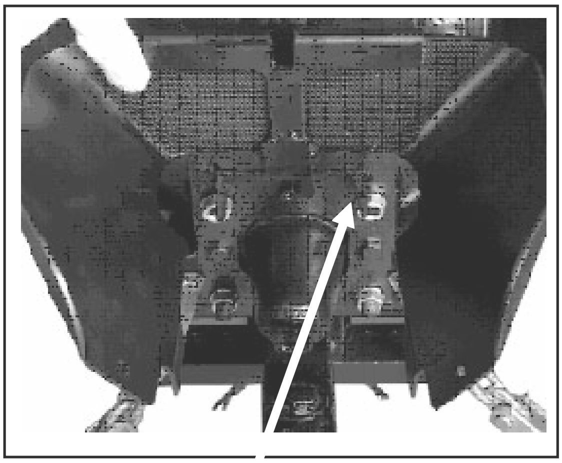


Fig 4

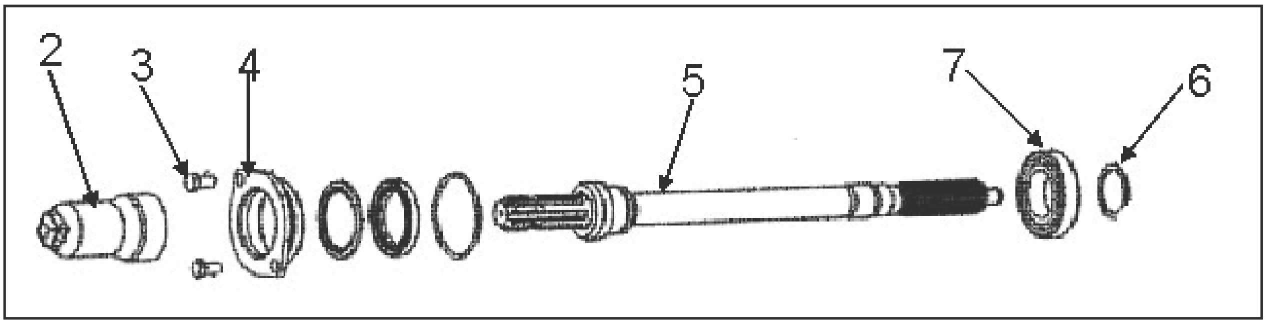


Fig 5

Refitment

8. Using SER / 046 to press the oil seal into PTO housing.
9. Fit a new ‘O’ ring.
10. Using a hydraulic press, press the new ball bearing onto the PTO shaft.
11. Fit a new snap ring and ensure that it locates correctly in its groove.
12. Slide the PTO shaft into the rear housing, taking care to keep it horizontal to align the internal spline.
13. Reinstall the PTO housing to the centre housing.
14. Tighten the four retaining nuts with spacers to a torque of 83-125 lbf.ft.(113 - 169 Nm)
15. Tighten the two bolts retaining the draw bracket to the check chain bracket to a torque of 170-192 lbf .ft. (230 - 260 Nm)

SECTION 12

PART B

INDEPENDENT POWER TAKE OFF

Indepedent power take off

Part B

Table of contents

Operation NO.	Descripition	Page no.
12B . 1	Specification	12B - 3
12B . 2	General descripition	12B - 4
12B . 3	IPTO operating switch	12B - 5
12B . 4	IPTO clutch unit removal from tractor	12B - 8
12B . 5	IPTO clutch unit over hauling	12B - 9
12B . 6	IPTO Pressure test and flow test	12B - 15
12B . 7	Removal and refitment of left hand side cover	12B - 16

12B . 1 IPTO - SPECIFICATION :

Lift pump output:

540 rev/min PTO speed – Low flow pump - 1789 engine rev/min

Engine to PTO shaft ratio:

Low flow pump - 3.313:1

PTO shaft:

Out side diameter - 1.3752 inch (34.93 mm)

No. of splines - 6

IPTO clutch :

Type - Multiplate

Size - 4.921 inch (125 mm)

Operation - Hydraulic

No. of Friction discs - 5 For MF 2605

- 7 For MF 2615

Thickness (new) - 0.086 inch (2.2 mm)

No. of steel plates - 4 For MF 2605.

- 6 For MF 2615

Thickness (new) - 0.062 inch (1.6 mm)

No. of return springs - 4

Type of spring - Coil

Clutch pressures:

Engine speed - 1500 rev/min

Oil temperature - 122°F - 140°F (50-60° C).

Clutch operating pressure - 18 .63 - 19.61 bar (270 - 285 psi)

12B . 2 GENERAL DESCRIPITION:

Single – Speed IPTO – Low flow Pump

The PTO drive is taken from the hydraulic lift pump running at a speed of 540 rpm giving a hydraulic flow of 16.7 lpm (4.4 gpm) at an engine speed of 1789 rpm.

The principal components of single speed IPTO comprise of hydraulic – operated multi-plate clutch and a electrical solenoid valve, operated by a Single Pole Double Throw Switch.

The IPTO clutch is located immediately to the rear of the linkage pump and is driven from an extension of the linkage pump drive shaft. This shaft is driven from the cover of the split torque transmission clutch, through the PTO reduction gears and drive shaft to the pump.

The rear extension shaft of the linkage pump is splined and is coupled with splined input shaft of the IPTO clutch assembly. The input shaft is connected through splines to a hub, which in turn is splined to seven (in MF2615 tractor) / five (in MF2605 tractor) Friction clutch discs (Friction material – Paper based). Six (in model MF2615)/four (In MF2605) corresponding inter clutch plates connected to the housing of IPTO clutch. Four springs on the IPTO clutch housing holds the clutch in the disengaged position and applies required brake torque. The main PTO shaft is splined to the output gear of the clutch assembly, connected to the clutch housing.

Rotation of the PTO shaft is controlled by the hydraulic clutch. It occurs when the driving friction plates and the driven (inter steel plates) are forced into engagement by the piston, this is operated by oil pressure through the left-hand side cover from solenoid valve and auxiliary hydraulic system.

The solenoid valve located outside the center housing and below the LH foot step acts as a direction control valve and maintains a constant pressure at a constant flow, to the clutch assembly, through hydraulic pipe lines via the LH side cover.

The solenoid valve is operated to ‘ON’ condition, by IPTO switch, located on ROPS, on the Right Hand side, near the driver’s seat. For safety, this switch has two-way action of pressing the switch in the center and pulling the switch upwards direction for ‘ON’ condition. When the solenoid valve is switched ‘ON’, it directs oil to the back of the piston, overcomes the four spring forces and engages clutch assembly at a constant pressure of 18 .63 - 19.61 bar (270 - 285 psi) and constant flow of 9 lpm (2.377 gpm). Oil is vented out from the between the plates through the slots on the housing, provided for the inter plates.

When the solenoid valve is switched ‘OFF’ (by pressing the IPTO switch downwards), the solenoid valve directs the oil from the auxiliary hydraulic system to the sump (Center housing), thus with drawing flow to the clutch assembly and disengaging the same.The four springs located in the housing ensures a fast return oil flow and a rapid disengagement of the clutch.The four springs also applies the brake by forcing the housing against a friction liner plate in the clutch assembly.This brake friction liner plate lug is held in between the Assembly Brake bracket, fastened inside the center housing.

When the IPTO switch is in ‘OFF’ condition (clutch disengaged condition), the neutral start switch is engaged.

The hydraulic system is fitted with a flow control valve, fastened to the LH side cover (towards the inside of the center housing), which regulates a constant flow of 9 lpm (2.377 gpm) to solenoid valve. The solenoid valve acts as a direction control valve, maintains a constant pressure at particular flow and as a modulating valve. The solenoid valve controls the rate of engagement of the clutch, by controlling the flow of oil into the clutch pack so that the engagement time is approximately with in 1.2 to 1.5 seconds, this prevents the clutch taking up the drive suddenly which could result in damage to the tractor or the implement. The settings of the flow control valve and the solenoid valve is factory set and are not adjustable.

12 B . 3 IPTO Operating switch:

The tractor is fitted with independent electrohydraulic controlled PTO clutch.

- Switch control for the power take off (B)

Do not leave the power take off clutch switch engaged longer than the time required for the operation. Always place the power take off clutch in neutral , shut off engine and engage parking brake before carrying out any adjustment or repair jobs on the implement connected to it.

1. To engage the PTO clutch,press (B) the switch (B) in the center , lift the outer ring and pull up .The selected PTO speed indicator light on the instrument panel illuminates.
2. To disengage press the switch down.

***Note:** The PTO engagement switch must be in the neutral / brake position (Fully down) to engage the neutral start switch so the engine can be started.*

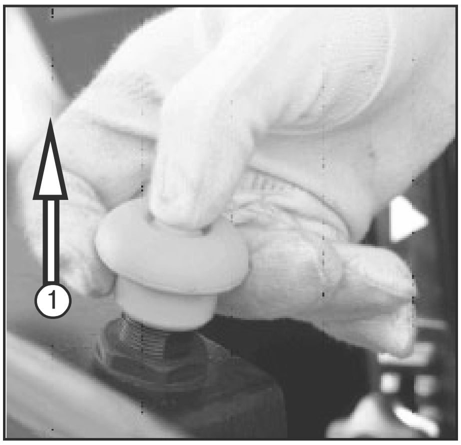


Fig 1

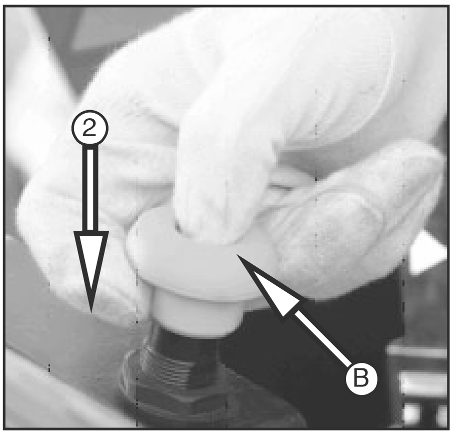


Fig 2

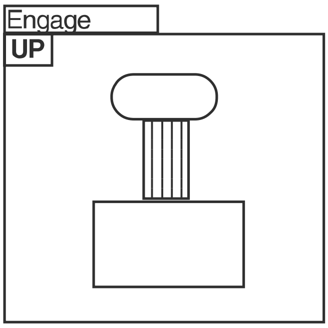


Fig 3

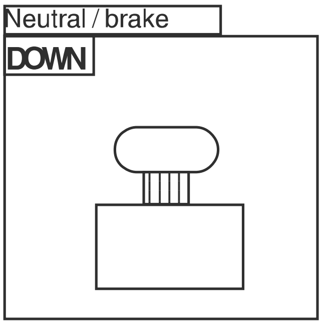


Fig 4

LAYOUT 2WD IPTO CLUTCH

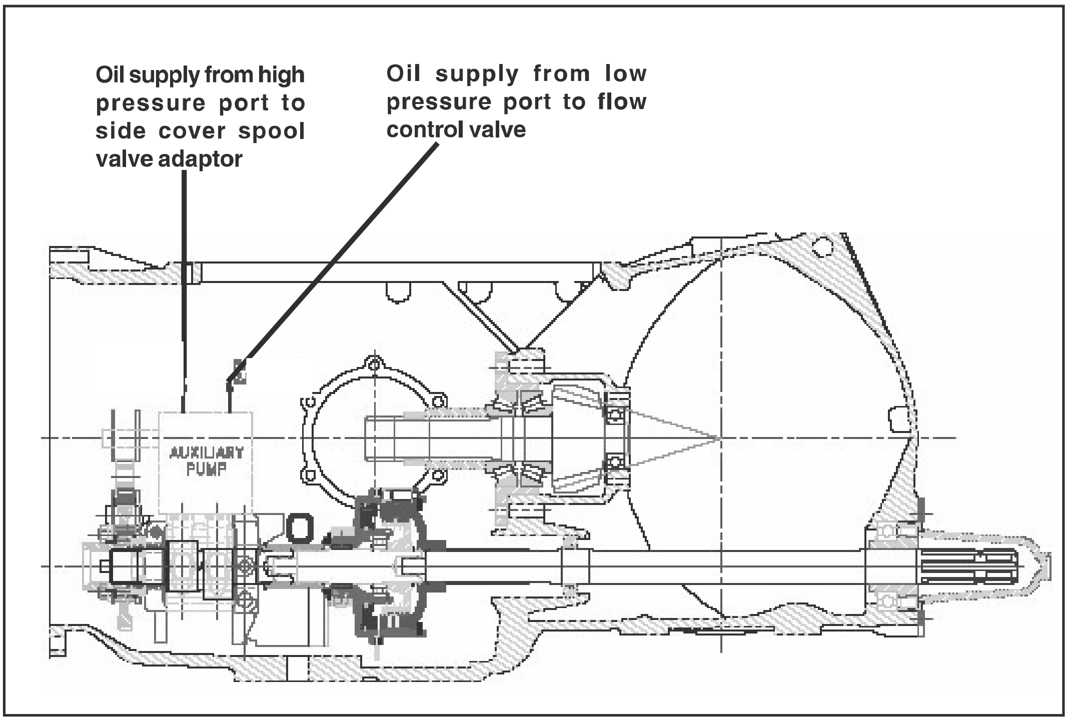

Oil supply from high pressure port to side cover spool valve adaptor
Oil supply from low pressure port to flow control valve
AUXILIARY PUMP

Fig 5

LAYOUT 4WD IPTO CLUTCH

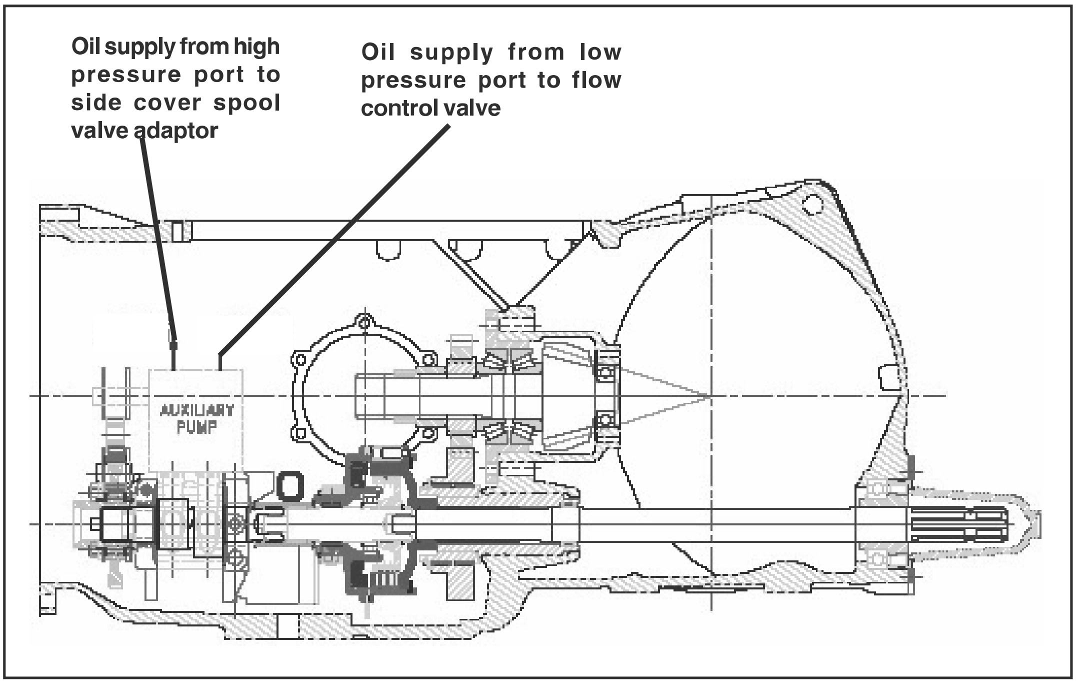

Oil supply from high pressure port to side cover spool valve adaptor
Oil supply from low pressure port to flow control valve
AUXILIARY PUMP

Fig 6

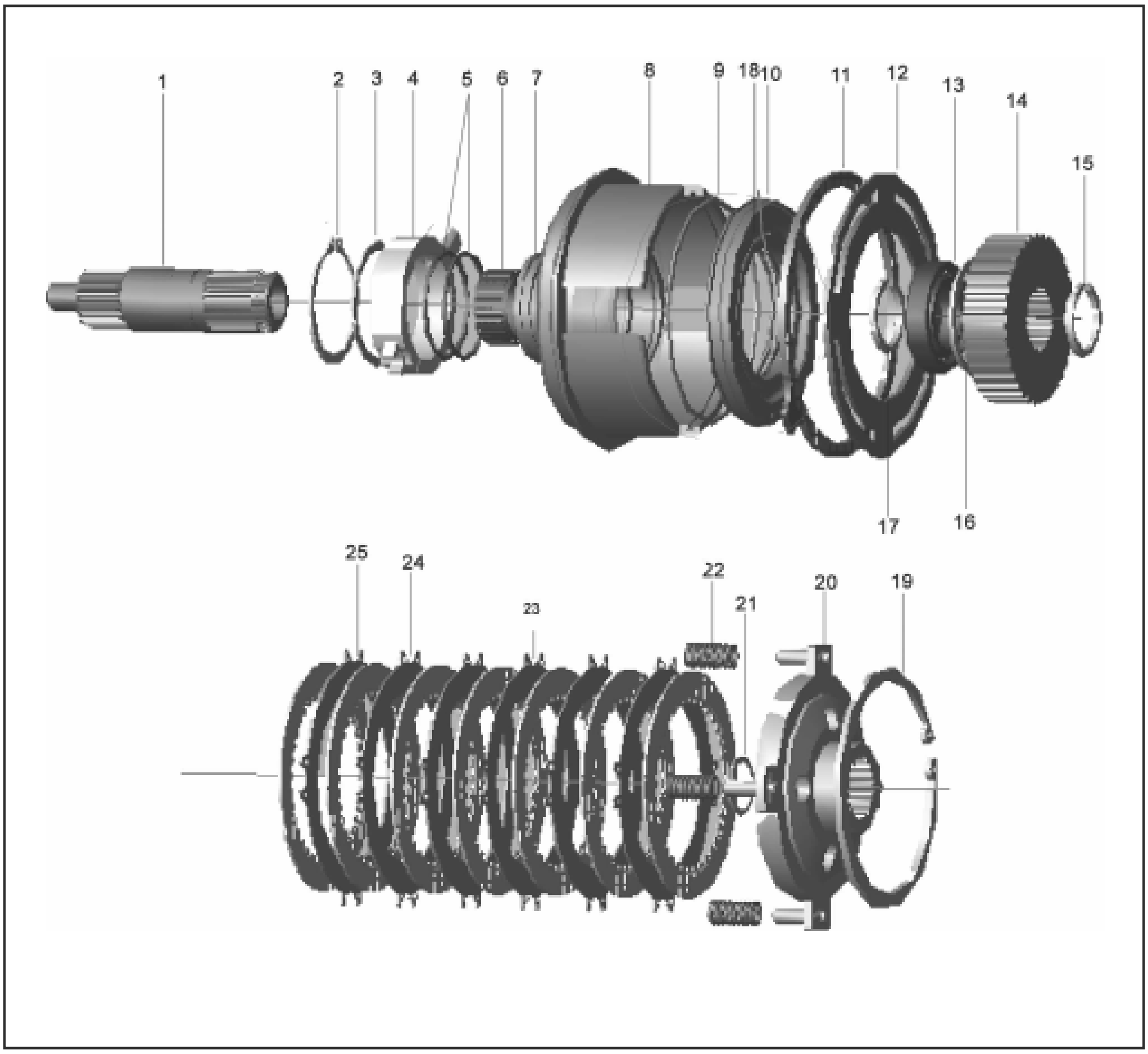


Fig 7

S.no	Descripition	Qty
1	Input shaft	1
2	Snap ring	1
3	Lock plate	1
4	Feed ring	1
5	Seal ring	2
6	Needle bearing	1
7	AV - Seal	1
8	Case	2
9	Seal ring	1
10	Piston	1
11	Brake disc	1
12	Brake plate	1
13	Ball bearing	1
14	Hub	1

S.no	Descripition	Qty	
15	Snap ring (shaft)	1	
16	Snap ring (Hole)	1	
17	Snap ring (shaft)	1	
18	Seal ring	1	
19	Snap ring (Hole)	1	
20	Pressure plate	1	
21	Snap ring (Hole)	1	
22	Spring	4	
23	Rubber separator	16	For 2615
		12	For 2605
24	Clutch disc	7	For 2615
		5	For 2605
25	Clutch plate	6	For 2615
		4	For 2605

12B . 4 IPTO CLUTCH UNIT

Removal and Refitment from tractor

1. Split the tractor between the rear centre housing and the range change unit, four-wheel drive drop box or spacer.(See operation 4A . 4)
2. Remove the lift cover.(See operation 11A . 5)
3. Remove the left-hand side cover, (see operation 12B . 7).
4. Remove the main drive shaft.
5. Remove the access plate, the hydraulic lift pump filter and stud extension.
6. Remove the two nuts and dowel pin on the left-hand side of the transmission case holding the lift pump. Remove the strainer housing on the right-hand side.

   NOTE: *The following procedure must be carefully followed otherwise extreme difficulty will be experienced in removing the pump.*
7. The lift pump and IPTO clutch pack must be held together and removed as one unit.
8. Carrying out the instructions in procedures 7 and 8, hold the lift pump and IPTO clutch pack assembly, manoeuvre the assembly forwards out of the centre housing.
9. Slide the clutch pack assembly off the lift pump drive shaft.
10. Remove the thrust washer .
11. Remove the coupler.
12. Remove the thrust washer.
13. Remove the snap ring.

Refitment

14. Refit the clutch assembly to the lift pump.
15. Ensure that the fork on the feed ring is correctly engaged on the pin on the lift pump.
16. Ensure that the brake disc lug of clutch assembly to be positioned between brake bracket fingers.
17. Reverse procedures 1 to 13 except:

    a. Fit new ‘O’ rings, gaskets and split pins.

    b. DO NOT tighten the two lift pump dowel nuts (5) until the transmission has been completely reassembled.

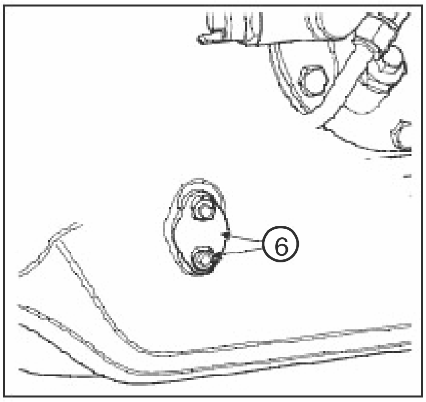


Fig 8

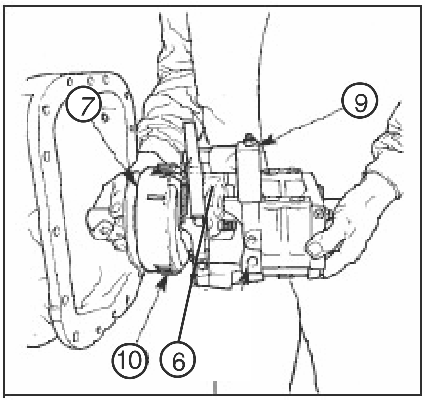


Fig 9

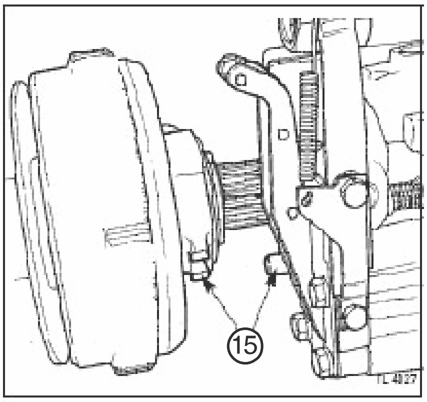


Fig 10

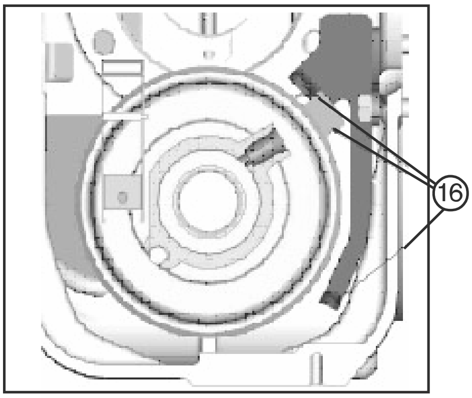


Fig 11

12B . 5 IPTO Clutch unit :

over hauling:

Removal

1. Press the pressure plate and remove the Snap ring using circlip plier.

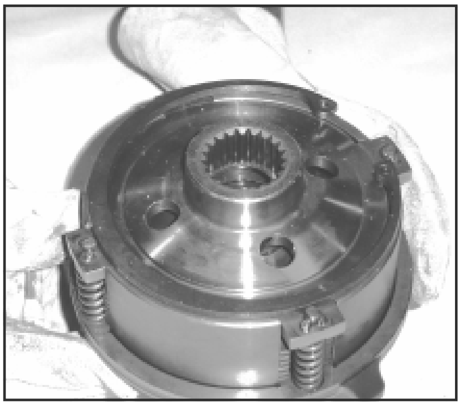


Fig 12

2. Remove the pressure plate.

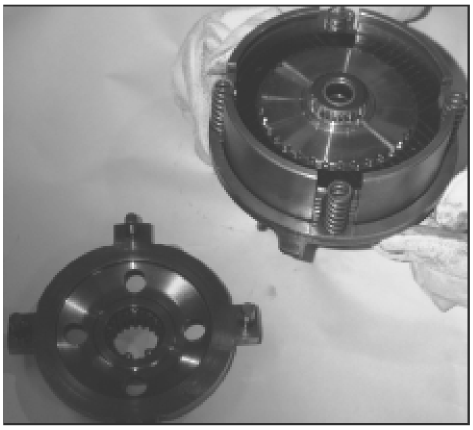


Fig 13

3. Remove the four springs.

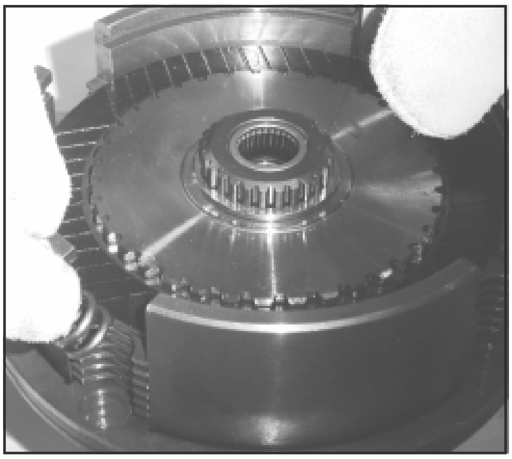


Fig 14

4. Remove the clutch disc and clutch plate one by one.

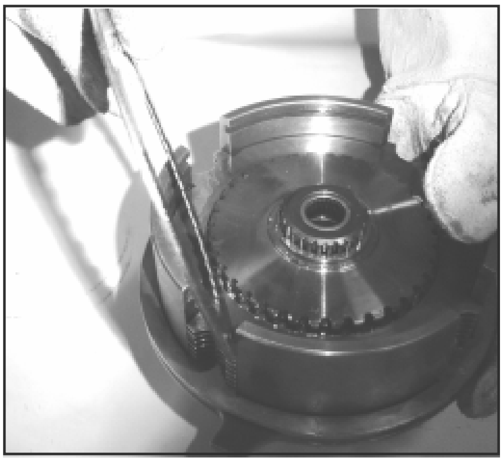


Fig 15

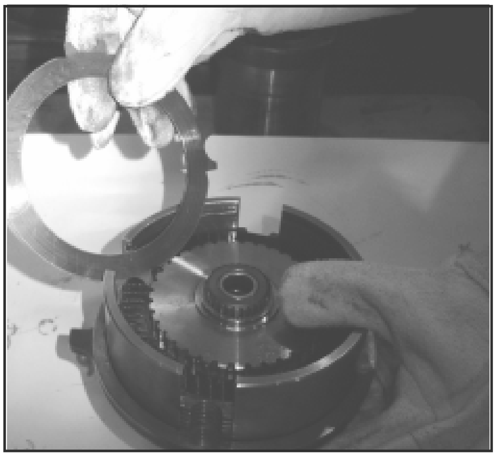


Fig 16

5. Remove the brake plate.

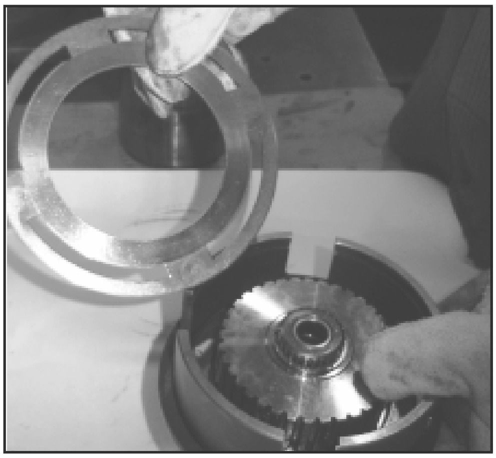


Fig 17

6. Remove the brake disc.

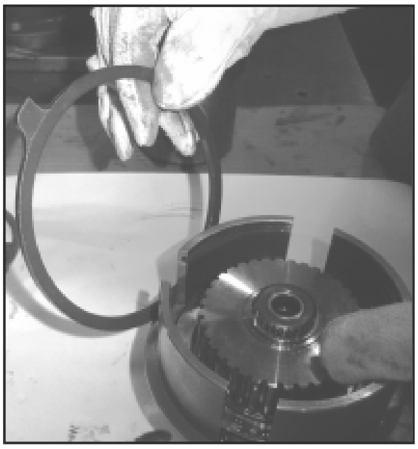


Fig 18

7. Remove the snap ring by using circlip plier from input shaft.

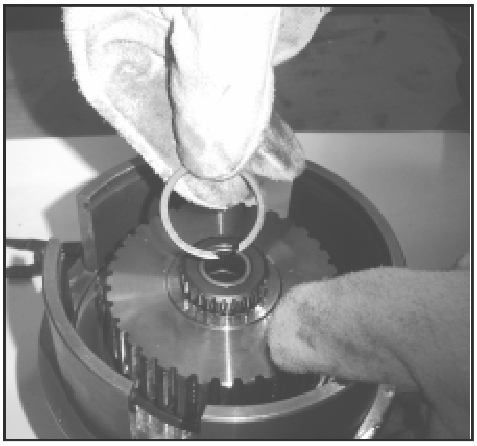


Fig 19

8. Remove the hub.

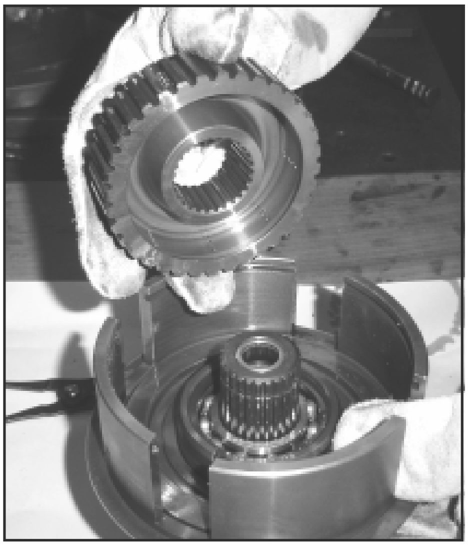


Fig 20

9. Remove the internal snap ring from inner case.

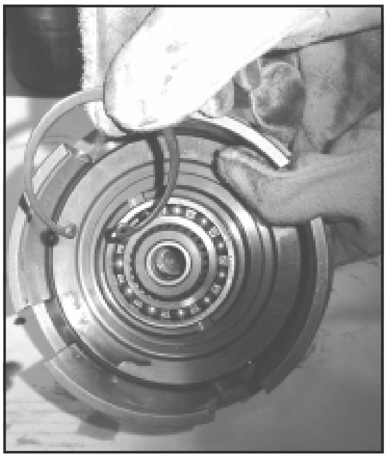


Fig 21

10. Pull the shaft forward and remove the shaft from housing along with bearing and also remove the needle roller bearing from the shaft.

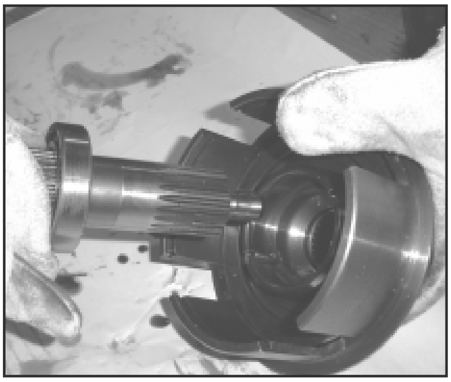


Fig 22

11. Remove the piston by passing the high pressure through the feed ring.

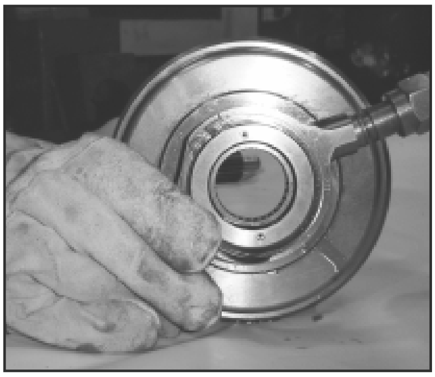


Fig 23

12. Remove the circlip from the rear side of the casing using circlip plier.

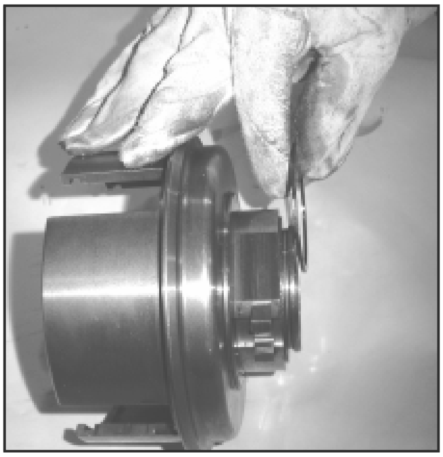


Fig 24

13. Remove the Feed ring .

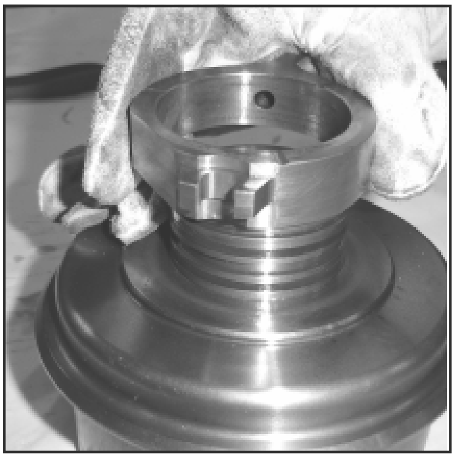


Fig 25

14. Remove the Teflon carbon ring from the housing.

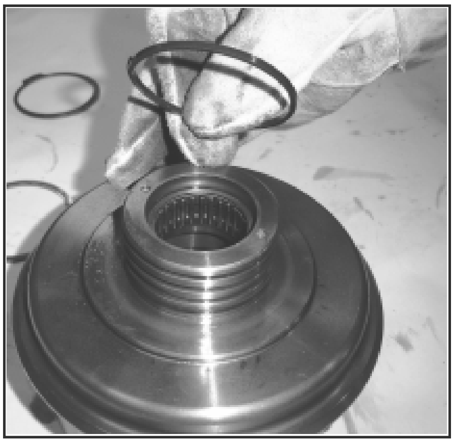


Fig 26

NOTE: Do not disturb the AV seal feed ring .

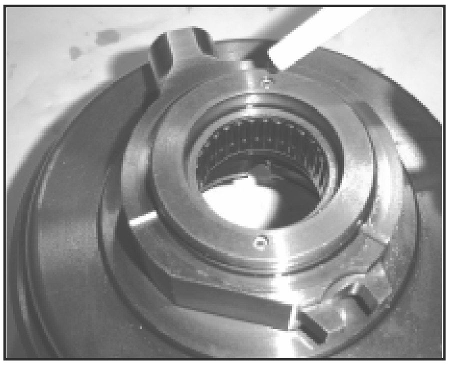


Fig 27

REFITMENT:

15. Reverse the procedure 1 to 14 except.

a.While refit the feed ring into the housing ensure the feed ring in its correct position .Measure the height between the housing and the feed ring (refer fig 28).

b.Replace the failured component by new one.

Note:*All disassembling and assembling operations are carried out in Dust free enviroment.*

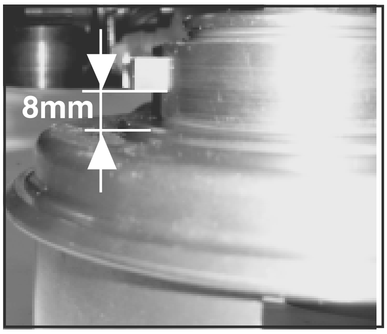


Fig 28

12 B - 6 IPTO Pressure test and flow test:

Before starting the test ensure that the transmission case is filled with clean transmission oil of the recommended grade oil.

1. Start the engine and warm up the transmission oil to a temperature of 120° - 140°F(50°c - 60°c) by running the hydraulic system under load.
2. Stop the engine and locate the outlet port of flow control valve to solenoid valve on left hand side cover.
3. From the left hand side cover, disconnect the line from the flow control valve outlet to the solenoid valve inlet.
4. Connect a 0 - 10 gpm (0 - 25 lpm) flow meter inlet line to flow control valve outlet port and the flow meter outlet line to the solenoid valve inlet port.
5. Restart the engine and increase the engine speed to 1500 rev / min.
6. The flow meter should read 2.37 (+0.264 / -0) gpm (9 (+1 / - 0) lpm) , flow rate. Stop the engine and reconnect the lines disconnected earlier.
7. Locate and remove the plug on left hand side cover for pressure test.
8. Fit the pressure gauge (upper limit 30 bar or 500 psi) at the pressure test point.
9. Restart the engine engage the IPTO and increase the engine speed to 1500 RPM.
10. With the transmission oil at the specified temperature the pressure reading should bulid up to 18 .63 - 19.61 bar (270 - 285 psi).With in a period of approximately 1.2 to 1.5 seconds,the minimum acceptable pressure is 15.7 bar (228 psi).
11. Reduce the engine speed to idling and disengage the IPTO.
12. Stop the engine,remove the gauge and refit the plug to test port.
13. Restart the engine, engage the IPTO and increase the engine speed to 1000 RPM, check for and repair any leaks of IPTO lines and at test plugs.

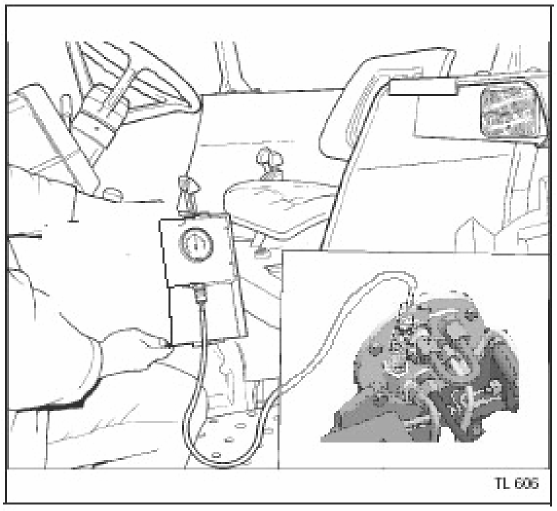


Fig 29

NOTE: *Flow control settings and solenoid valve settings are set at factory and should not be adjusted in service.*

Diagnosis for low oil flow:

1.If the flow is below the recommend specification, the following should be checked.

a.Leakage at hydraulic pump and the flow control valve.
b.Suction strainer for plugging.
c.Auxiliary hydraulic pump condition.
d.Oil level in the tractor should not be less than the minimum level on the dipstick.

Diagnosis for low oil pressure:

1. If the pressure is below the the minimum specification, the following should be checked:

a.Leakage at IPTO clutch pack ring.
b.Leaking in transfer pipe between side cover and clutch.
c.Leaking IPTO clutch pack piston seals.

12 B - 7 Left hand side cover

Removal and refitment :

Removal:

1. Park the vehicle on level ground and apply parking brake.
2. Pull the hood latch cable and lift the hood.
3. Disconnect the battery terminals.
4. Drain the oil from transmission and hydraulic.
5. Remove the U - Pipe connection.
6. Remove the 'O' ring.
7. Remove the left hand foot step for easy accessablity of solenoid valve pipes .

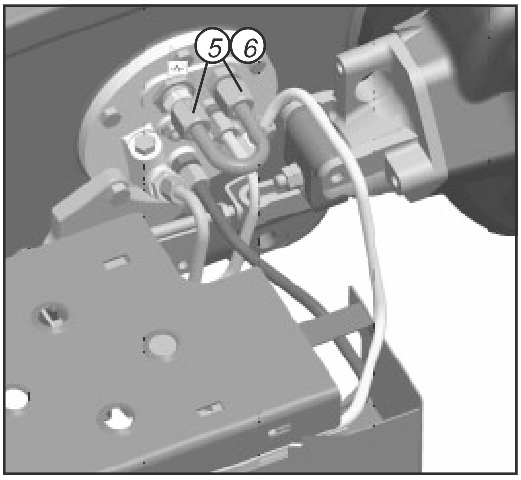


Fig 30

8. Remove the bracket mounting bolts.

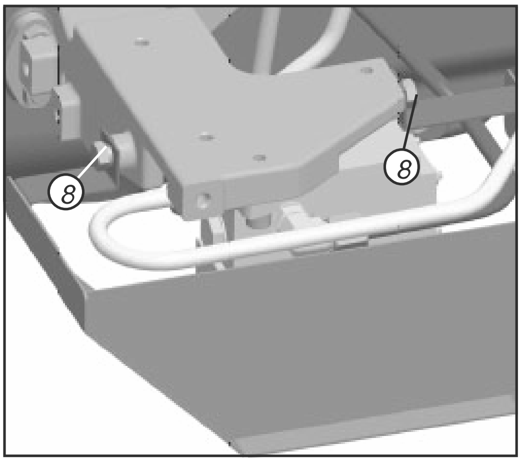


Fig 31

9. Remove the hydraulic lines which connects the side cover and the solenoid valve.

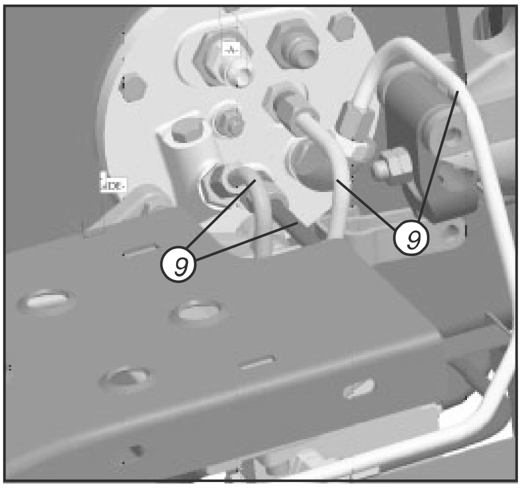


Fig 32

This picture shows the bottom view of solenoid valve with pipe connections.(For clarify)

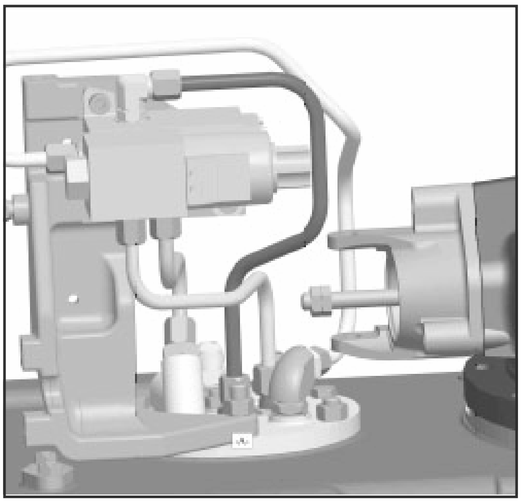


Fig 33

10. Remove the solenoid mounting allen screws.

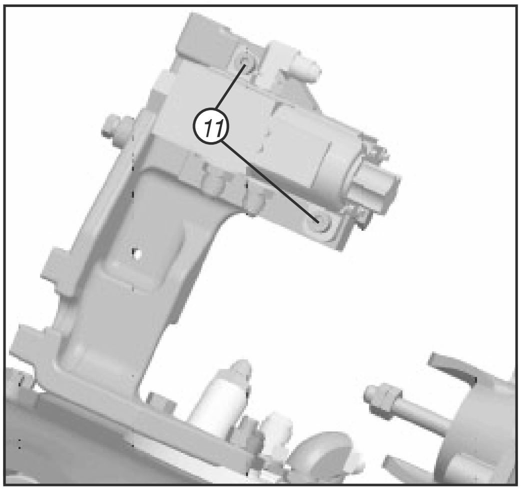


Fig 34

11. Remove the supply tube by using hook type tool.

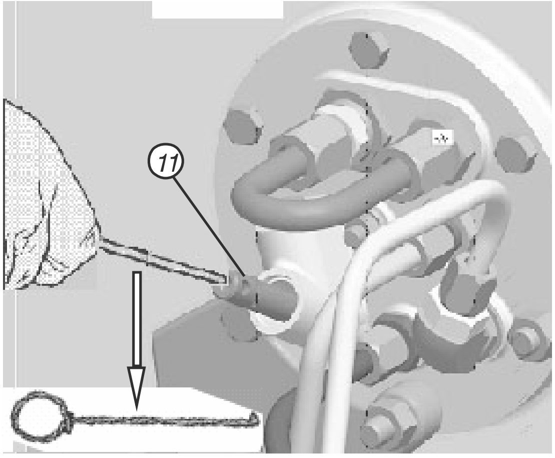


Fig 35

12. Remove the nuts.
13. Remove the ‘O’ rings.
14. Remove the solenoid valve mounting bracket bolts and remove solenoid valve mounting bracket.

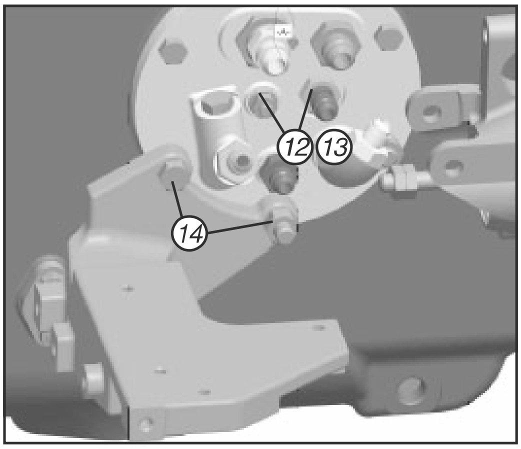


Fig 36

15. Remove the left hand side cover mounting bolts.
16. Remove the left hand side cover.
17. Remove the gasket.

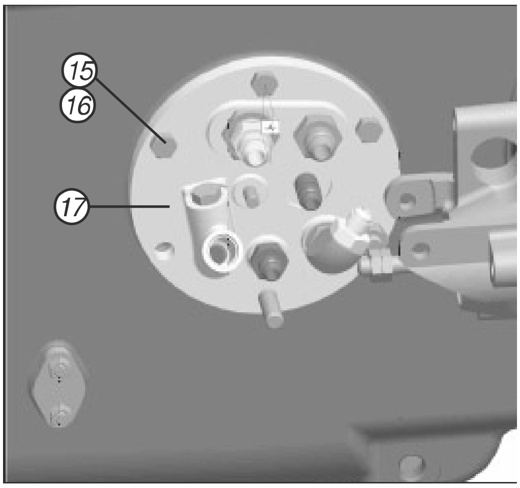


Fig 37

NOTE:Clean and inspect all the components and renew all the ‘O’ rings and gasket.

Refitment:

18. Reverse the procedure 1 to 17 except Installation of supply tube:
    a.Insert a guide rod to the feed ring through side cover as shown in figure.
    b.Align the groove in the guide rod to side cover face.
    c.Guide the supply tube over the guide rod to the feed ring and ensure the 31.5 mm height from side cover to supply tube.
    d.Carefully remove the guide rod from the side cover and refit the bolt.
19. Seal the six bolts threads with Loctite and tighten the bolts.

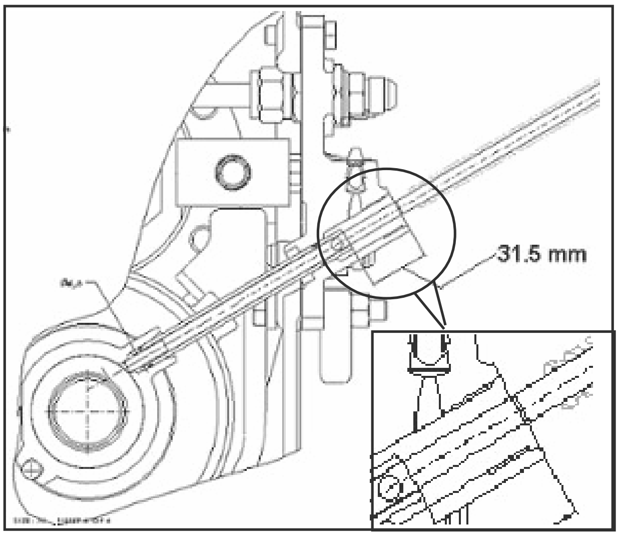


Fig 37

SECTION 14

PART A

GENERAL ELECTRICALS

GENERAL ELECTRICALS

Operation NO	Description	Page No
14 A . 1	Specification	14 A - 3
14 A . 2	General description	14 A - 3
14 A . 3	Servicing the electrical system	14 A - 4
14 A . 4	Preliminary checks	14 A - 4
14 A . 5	Routine maintenance	14 A - 4
14 A . 6	Maintenance free battery	14 A - 5
14 A . 7	Preparation of dry charge batteries	14 A - 6
14 A . 8	Recharging in servicing	14 A - 6
14 A . 9	Boost charging	14 A - 7
14 A . 10	Battery removal and refitment	14 A - 7
14 A . 11	Head light beam adjust	14 A - 8
14 A . 12	Removal and refitment of head light	14 A - 8
14 A . 13	Removal and refitment of Flashing indicator light	14 A - 9
14 A . 14	Removal and refitment of Turn indicator bulb	14 A - 9
14 A . 15	Removal and refitment of work lamp bulb	14 A - 10
14 A . 16	Check - Fuel tank sender unit	14 A - 11
14 A . 17	Removal and refitment of starter switch	14 A - 11
14 A . 18	Removal and refitment of light switch	14 A - 12
14 A . 19	Removal and refitment of turn indicator switch	14 A - 12
14 A . 20	Check air cleaner restriction sensor	14 A - 13
14 A . 21	Removal and refitment of trailor socket	14 A - 13
14 A . 22	Fuses and relays	14 A - 14
14 A . 23	Arrangement of fuse for MF 2615	14 A - 15
14 A . 24	Arrangement of fuse for MF 2605	14 A - 16
14 A . 25	Check relays	14 A - 17
14 A . 26	Instrument cluster	14 A - 18
14 A . 27	Removal and refitment of instrument cluster	14 A - 20
14 A . 28	Instrument cluster - over hauling	14 A - 21
14 A . 29	Wiring diagram for MF 2605 / 2615 (2WD / 4WD)	14 A - 26
14 A . 30	Fault diagonsis	14 A - 36

14 A . 1 SPECIFICATION :

Voltage	...	12 volt negative earth system
Head light high/main beam	...	35 W
Head light low/dip beam	...	35 W
Type	...	RH Traffic , Halogen.
Light , side turn indicator	...	21 W
Work lamp	...	55W , Halogen.
Horn	...	5A.
Hazard warning system	...	Light switch operated.
Light switch type	...	Rotary.
Turn indicator switch type	...	Double pole double throw switch.
Trailer socket	...	As per ASAE S279.13 Std.

14 A . 2 General description:

The electrical system for the 2600 series tractor is a 12 volt negative earth system, charged by an engine mounted alternator. The alternator has an integral rectifier and regulator, with the charging control being machine sensed.

The alternator is mounted on the right-hand side of the engine and is driven by a V-belt from the crankshaft pulley. Adjustment of the V-belt tension is provided for with a slotted link and clamp bolts.

The starter motor is supplied in either standard duty or heavy-duty form and it is mounted on the right-hand side on MF2605 tractor and left-hand side on MF2615 tractor.

A neutral start switch is fitted on the top of the transmission and on the PTO cover . This renders the starter motor inoperative until the dual range selector lever is in the neutral position and the PTO lever in the disengaged position.

Fuses are fitted to protect the lighting, and horn circuits. Wiring diagrams will be found in this section .

The battery access on the three cylinder tractors is located immediately in front of engine radiator.

14 A . 3 Servicing the electrical system:

***IMPORTANT :** Always disconnect the alternator wiring before removing the battery leads.*

1. Before any operation is carried out on the tractor electrical system , always disconnect the battery leads.
2. To prevent damage to the voltage regulator do not conect or disconnect any part of the charging circuit including the battery while the engine is running. (This action may damage the voltage regulator).
3. When disconnect the alternator , slave battery or battery charger to the tractor always observe correct polarity ,(Positive to positive , negative to negative) or damage to the voltage regulator and rectifier may occur.

WARNING : If at any time , it is necessary to remove the battery from the tractor , on refitment always ensure that the battery leads are reconnected correctly *THE FIRST TIME* , since even a momentary connection of the wrong lead , with the other lead already in correctly connected , will cause serious damage to the alternator.

Battery Lead Connecting Sequence:

Connect the positive lead (+) to the terminal marked red.

Connect the negative lead (-) to the terminal marked black.

Reverse sequence for battery lead disconnection.

14 A . 4 Preliminary checks:

If the charging circuit is faulty , indicated by a flat battery , frequent topping - up of the electrolyte or the warning light staying on throughout the engine speed range check:

a. That all cable connections are clean and tight .

b. That all components and wiring are without signs of over heating or damage.

c. That the alternator drive belt tension is correct and adjust as necessary.

d. That the battery is serviceable and the connections are in good condition.

For the complete list of electrical system faults, together with their symptoms and remedies , consult fault finding table.

14 A . 5 Routine maintenance

***A . Battery**:*

Check the electrolyte level in the battery after every 500 hrs or 6 months of operation and top up with distilled water as necessary.In an emergency , clean rain water or melted snow can be used in place of distilled water. Never use salt water ,Cholorinated water , chemically soften water, boiled water,or stagnant water .Make sure that the filler plug or cover plate vent holes are kept open and free of dirt at all times. The battery top should be kept clean , any moisture or dirt being wiped off at regular intervals. Dilute ammoina on a lint free cloth should be used for removing any traces of sulphation from the battery top or terminals.The battery posts should be kept clean and the connection checked periodically for tightness. To maintain a dry , clean contact between the battery post and terminal clamp , the terminals should be smeared with grease

B. Alternator:

Routine maintenance is limited to wiping away any oil or dirt which may have accumulated around the openings on the alternator and ensuring that the drive belt is correctly tensioned .The alternator bearings are lubricated on initial assembly and no futher lubrication is needed during service etc.

C. Fuses:

In the case of a blown fuse , the cause must always be identified and rectified before replacement of the fuse. Only fuses of the same capacity may be used for replacement purpose . for the correct fuses , see the list on the fuse list page.

14 A . 6 Preparation of Dry charge batteries

Batteries intended for export markets are supplied dry charged and must be filled with electrolyte of the correct specific gravity according to the climate ,before being put in to service.

Dry charged batteries plates leave the manufacturer in a charged state but slowly discharge while in storage.

Batteries should be filled with electrolyte as near to the commencement of service as is practicable.

It is normally necessary to give an initial charge after filling . The charge should be for a period of 2 hours at a rate equal to 2% of the - 64.4°F (18°C) current as indicated on the performance label.

Initial filling is acheived by removing cell covers and filling each cell with electrolyte of the correct specific gravity to a level of 0.236 inch (6 mm) above the seperators.

After filling is complete the battery must sit 20 minutes prior to charging . If after this 20 minute charging period , the casing of the battery feels warm to the back of the hand , it should be assumed that the battery has become completely discharged during storage and therefore the charging period should be extended to 12 hours at a current equal to 2 % of the - 64.4°F (18°C) cold performance amps.

During the charging the electrolyte temperature should not exceed 95°F (35°C) .

While charging do not touch connections or any part of battery.

At the end of charge switch off first and allow the battery to stand a few minutes for the dangerous gases to disperse.

Electrolyte:

The eletrolyte for a dry charged battery is diluted sulphuric acid . The volume for this battery is approx 9 Lts.

The specific gravity of the electrolyte required when filling is :

a.Climates normally below 77°F (25°C) 1.270 corrected to 77°F (25°C).

b.Climates normally above 77°F (25°C) 1.240 corrected to 77°F (25°C).

The dilution of concentrated sulphuric acid with a specific gravity above 1.400 should only be undertaken by qualified chemical workers.

On Completion of Initial Charge:

On completion of charging , check the specific gravity in the cell to ensure that it is within specified limits for a fully charged battery shown on corrected to 77°F (25°C).

If any cell requires adjustment , some of electrolyte must be siphoned off and replace either by distilled water or electrolyte of the specific gravity used originally in the filling of the battery , depending on wheather the specific gravity is too high or low.

NEVER TRANSFER ELETROLYTE FROM ONE BATTERY OR CELL TO ANOTHER.

If adjustment was necessary continue the charging for an hour to ensure adequate mixing of the electrolyte and again check the specific gravity readings .If necessary repeat the adjustment process untill the correct specific gravity readings are obtained in each cell.

Hydrometer Usage:

The specific gravity of electrolyte is measured using a hydrometer . The readings obtained from each cell should be approximately the same i.e. within the same battery the variation from the highest to the lowest should not exceed 0.020 specific gravity.

The electrolytes specifc gravity varies with tempertaure .All calculation are always corrected to 77°F (25°C). this is known as the reference temperature.

NOTE : *The temperature must be indicated by a thermometer actually immersed in the electrolyte preferably in one of the centre cells.*

All specific gravity readings should be corrected to the reference temperature . This is obtained by deducting 0.007 for every 50°F (10°C). below and adding 0.007 for every 50°F (10°C). above 77°F (25°C).

Safety Notes :

Remove dangerous articles of clothing such as bracelets, necklaces, watches and rings which can cause unwanted short circuits. At all times when handling batteries eye protection must be worn.

Never use an open flame and be particularly careful when using metal tools during the process of examining batteries. Batteries during and immediately, After charge give off a mixture of oxygen and hydrogen. This mixture , if ignited by a spark of flame may lead to an explosion.

14 A . 7 Maintenance free battery:

Maintenance free batteries where fitted as original equipment into Massey- Fergusion tractors require no topping up or checking of electrolyte levels during the life time of the battery.

These batteries are fitted with vented covers and under normal service conditions should not be removed for maintenance.

For capacitance testing operation Where the battery is to be recharged from an external supply or boost is required operation.

Electrolyte Replenishment :

Check the battery electrolyte level every 500 hours or 6 months.

1. Remove the cover plates or plugs.
2. Check that the electrolyte level just covers the battery plates.
3. If the level is incorrect ,top up each cell with distilled water to the correct level.
4. Refit the cover plates or plugs.

   NOTE : *Where maintenance free batteries are fitted , no check on electrolyte level is required during the batteries life.*

BATTERY:

Capacitance testing:

Special tools : Crypton battery tester model B51 or equivalent

1. The gases given off by the cells of a battery are explosive. Always use the the battery tester in a well ventilated area.
2. Set the battery tester for:

   a. 12V operation.

   b. a discharge rate , equal to the cold performance amperage.
3. Connect the probe on the tester to the battery positive (+) terminal.
4. Connect the probe on the flexible cable to the battery negative (-) terminal.
5. Test the battery for 15 seconds only , while noting the voltmeter behavior on the upper color scale.
6. A reading in the green zone indicates the battery to be in a satisfactory condition.
7. If the reading is in yellow zone or below , charge the battery and retest.
8. If the meter reading is now in the green zone , the battery is serviceable. A continuous reading in the yellow zone usaully indicates a faulty or worn out battery.
9. If after charge the meter reading falls progressively during the 15 seconds and ends in the red zone , the battery needs to be replaced.

14 A . 8 RECHARGING IN SERVICE:

Hydrometer Test :

The specific gravity of the electrolyte indicates the state of charge in the battery . Using a hydrometer check the specific gravity of the electrolyte in each battery cell and compare the readings with those in the table below.

Electrolyte Temperature Correction :

For every 50^{O}F (10^{o}C). below 77^{O}F (25^{o}C). deduct 0.007 from the specific gravity reading to obtain the true value specific gravity at 77^{O}F (25^{o}C). If the specific gravity of individual cells varies by more than 0.040 the battery should be considered for replacement.

NOTE: Hydrometer readings should not be taken if the battery has just been topped up . Charge the battery for 1-2 hours before testing.

Recharging from an External Application :

If the battery is found to be less than 70% charged, it should be re-charged using an external source . The charging current should be 2% of the cold performance amperage , indicated on battery information decal. Before recharging , make sure that the battery filler plug or cover plate vent holes are open and free of dirt. The battery is fully charged when the specific gravity of the electrolyte and voltage show no increase over three successive hourly readings .During the charge ,the electrolyte level should be checked regularly and replenshied as necessary with distilled water.

14 A . 9 BOOST CHARGING :

Boost charging must be regarded as an emergency measure only, maintenance free batteries must not be boost charged .

Boost charging must be limited to a maximum period of one hour only , with a charge rate of 20% of the cold performance amperage or 30 amps whichever is the smaller.

As the battery state -of- charge rises , the charging rate will fall , but must not be re-adjusted to the original stage.

IMPORTANT : *Always disconnect the alternator wiring before removing the battery leads.*

NOTE : *When reconnecting the battery leads*
Connect the positive lead to the terminal marked (+).(RED).
Connect the negative lead to the terminal marked (-).(BLACK).

Note : *The cover/caps must be fitted at all times , except when checking the electrolyte level. Wipe the battery top and smear the terminals with petroleum jelly.*

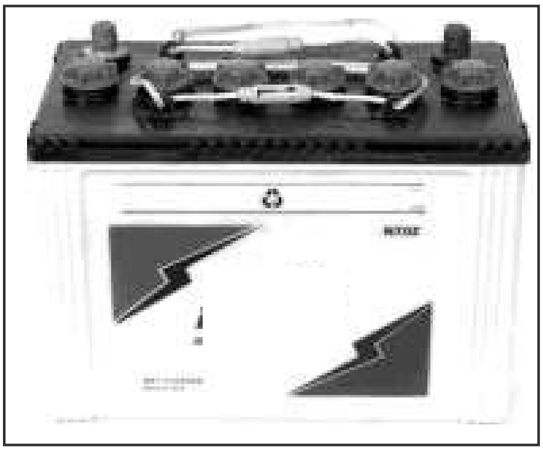


Fig 1

Sl.NO	State of charge	Specific gravity reading	
		Climate normally below 77°F (25°C).	Climate normally above 77°F (25°C)
1	Fully charged	1.270 - 1.290	1.230 - 1.250
2	70% charged	1.240 - 1.260	1.200 - 1.210
3	Discharged	1.110 - 1.130	1.090 - 1.100

14 A . 10 BATTERY:

Removal and refitment of battery:

Removal:

1. Pull the hood latch cable and lift the hood.
2. Disconnect the battery positive and negative terminals. First in the interest of safety.
3. Remove the wing nuts and washer in both left and right hand side .
4. Lift out the battery hold-down plate with battery hold-down rod
5. Remove the battery from the tractor.

Refitment :

6. Reverse the procedure 1 to 5 except.

   a. Smear the battery terminals and hold-down rod wing nuts with petroleum jelly.

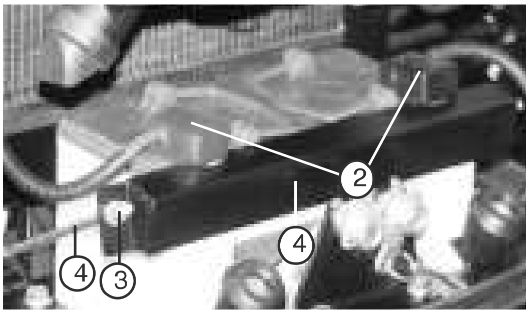


Fig 2

14 A . 11 HEADLIGHT BEAM

Adjust

To adjust the headlights, screw the three screws in or out as required, this will deflect the beam up, down or sideways.

1. Position the tractor facing a wall or screen 7,5 m(25 ft) away, distance (A).
2. Draw a horizontal line on the wall or screen (1) the same as the centre height of the headlights from the ground (B).
3. Draw two vertical lines (2),the same as the horizontal centre to centre distance between the headlights (C), 9.055 inch (230 mm).
4. Draw a second horizontal line (3) at a distance (D) below and parallel to line (1). Distance (D) is calculated by multiplying distance (B) by 0.1; for example,headlight height 44.48 inch (1130 mm) x 0.1 = 4.448 inch (113 mm).
5. Adjust each headlight, on main beam, individually by covering the opposite one and aligning the upper edge of the illuminated zone to line (3).

14 A . 12 HEADLIGHT BULB

Removal and refitment

Removal

1. Switch off all light switches.
2. Lift the hood
3. Remove the headlight wiring plug.
4. Turn and Remove the rubber surround (3).
5. Remove the bulb (4).

Refitment

6. Replace the bulb and re-assemble in reverse order.
7. Lower the hood and test.

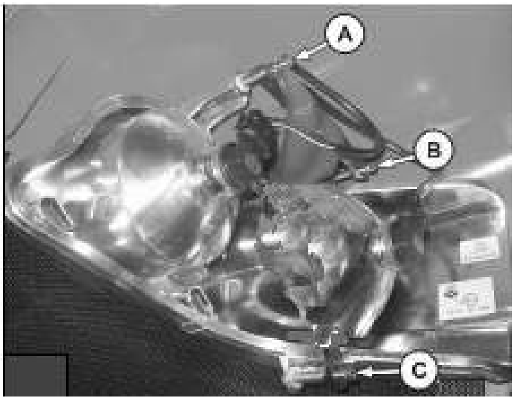


Fig 3

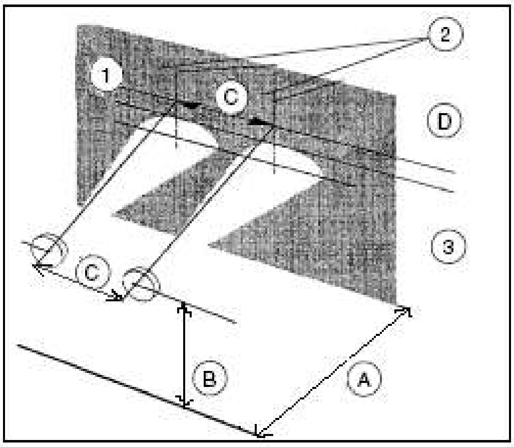


Fig 4

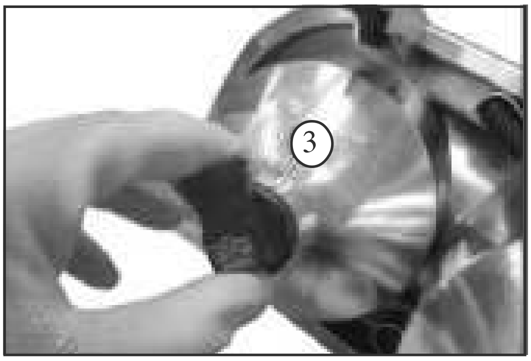


Fig 5

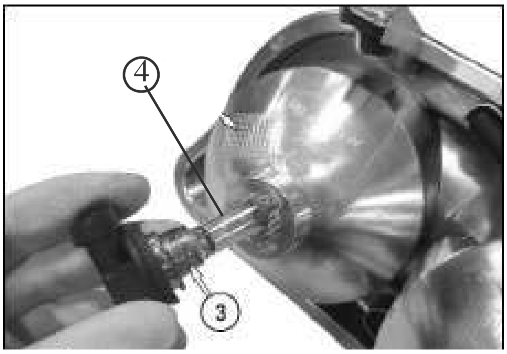


Fig 6

14 A . 13 FLASHING INDICATOR BULB:

Removal and refitment

Removal

1. Remove the two screws attaching the lens.
2. Remove the lens.
3. Remove the failed bulb from its bayonet fitting (3).

Refitment

4. Fit the bulb to the bayonet fitting.
5. Replace the lens and tighten the attaching screws.
6. Test the lights.

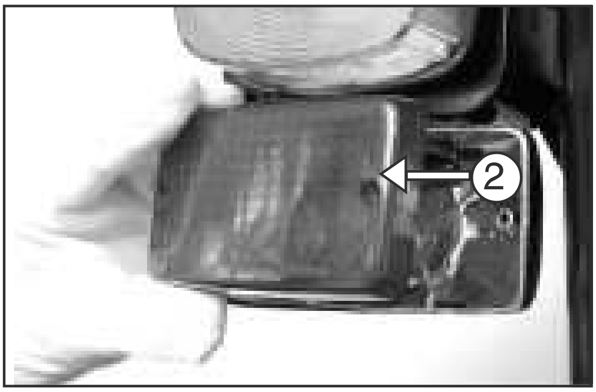


Fig 7

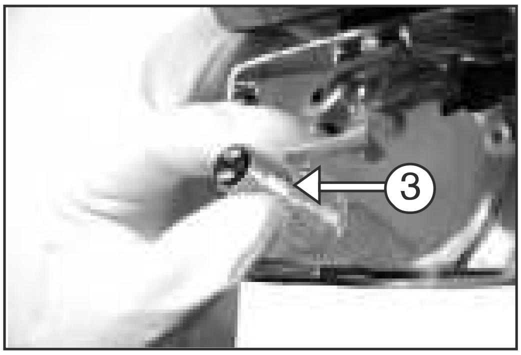


Fig 8

14 A . 14 TURN INDICATOR BULB

Removal and refitment

Removal

1. Remove the two screws attaching the lens.
2. Remove the lens.
3. Remove the failed bulb from its bayonet fitting.

Refitment

4. Fit the bulb to the bayonet fitting.
5. Replace the lens and tighten the attaching screws.
6. Test the lights.

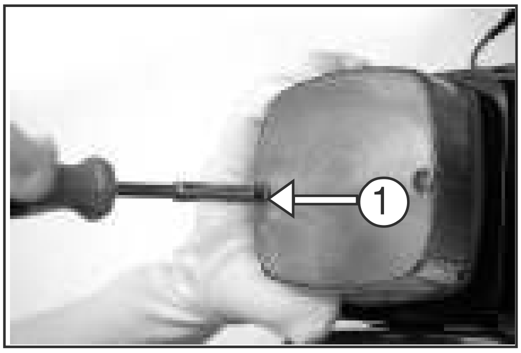


Fig 9

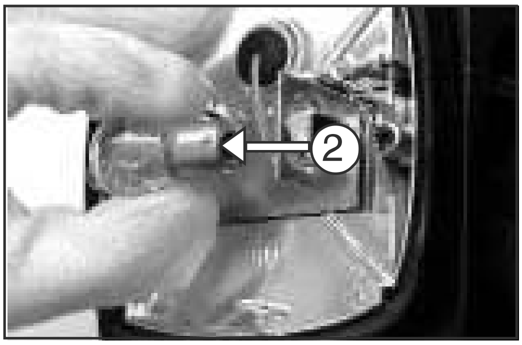


Fig 10

14 A . 15 WORK LIGHT BULB

Removal and refitment

Removal

1. Remove the retaining screws.

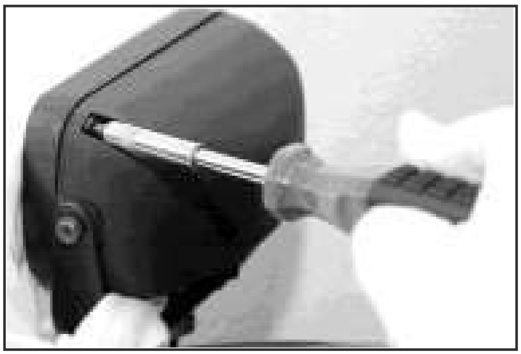


Fig 11

2. Ease the light unit out of the body.

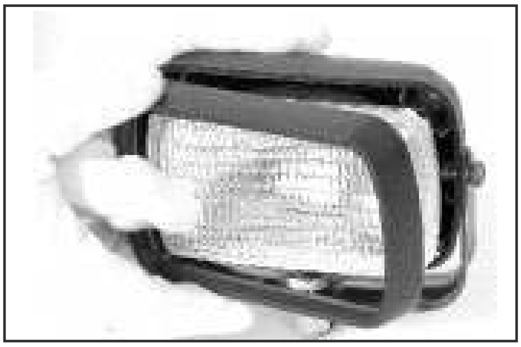


Fig 12

3. Remove the spring clip from the back of the bulb.

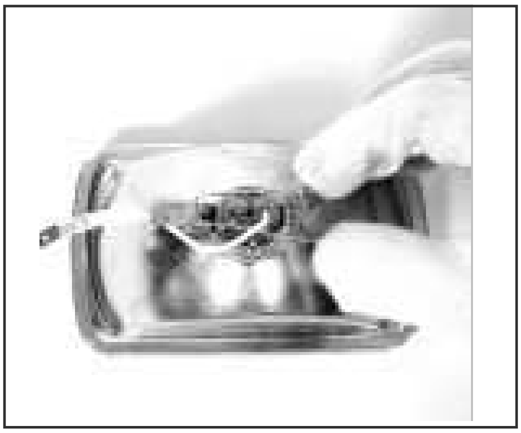


Fig 13

4. Remove the bulb .

Refitment

5. Reverse the procedure 1 to 4 except .
   a. Replace the failed bulb with a new one.

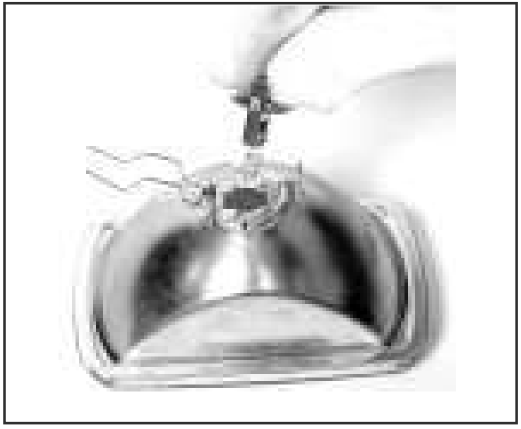


Fig 14

14 A . 16 FUEL TANK SENDER UNIT:

Check

Test Equipment: MF.3005 Digital Multimeter

Procedure

1. Disconnect the plug to the fuel tank sender unit.
2. Connect the MF.3005 Digital Multimeter between terminals 1 and 2. Terminal 3 is the connection for the 'Low fuel' warning light.
3. Check the contents of the fuel tank.
4. The approximate resistance reading should be as follows:

Tank contents	Meter reading
Full	6 - 8 ohms
Three quarter full	58 - 62 ohms
Half full	115 - 119 ohms
Quarter full	172 - 178 ohms
Low fuel light ON	234 - 240 ohms
Empty	322 - 332 ohms

5. This test will give an indication if there is a fault with the sender unit.

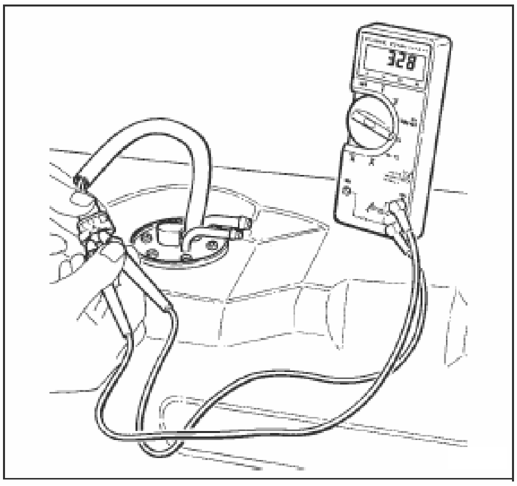


Fig 15

14 A . 17 STARTER SWITCH

Removal and refitment

Removal

1. Remove the instrument cowl.
2. Lift the hood and disconnect the battery removing the negative cable (-) first in the interest of safety.
3. Remove the rubber cover from the switch
4. Label and disconnect the wires from the rear of the switch.
5. Remove the slotted nut surrounding the key hole in the starter switch.
6. Withdraw the switch from behind the instrument panel.

Refitment

7. Reverse procedures 1 to 6.

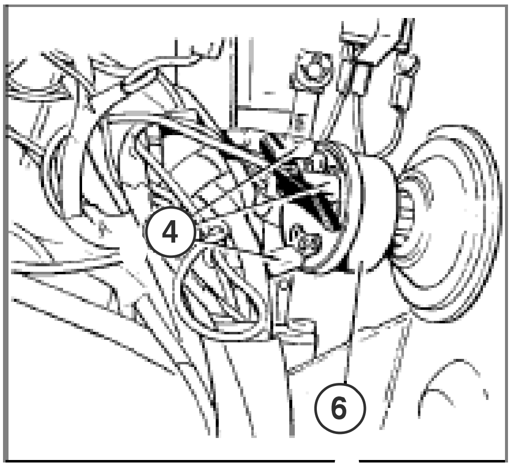


Fig 16

14 A . 18 LIGHT SWITCH

Removal and refitment

Removal

1. Remove the instrument cowl.
2. Lift the hood and disconnect the battery, removing the negative cable (-) first in the interest of safety.
3. Press the plunger with suitable pin and release the knob from switch.
4. Remove the spring (if fitted).
5. Label and disconnect the two connectors from the switch terminals.
6. Remove the locknut.
7. Withdraw the switch from behind the instrument panel.

Refitment

8. Reverse procedures 1 to 7.

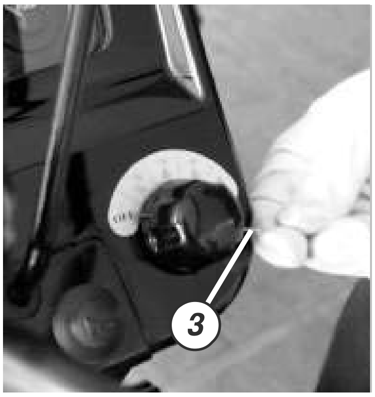


Fig 17

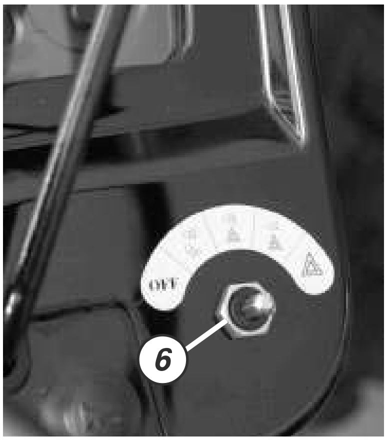


Fig 18

14 A .19 TURN INDICATOR SWITCH:

Removal and refitment

Removal

1. Remove the lower instrument panel.
2. Pull the indicator switch arm off the indicator switch, away from the instrument panel by pressing the plunger with suitable pin.
3. Remove the lock nut.
4. Remove the harness connector from the rear of the switch.
5. Remove the switch from its mounted position.

Refitment

6. Reverse procedures 1 to 5.

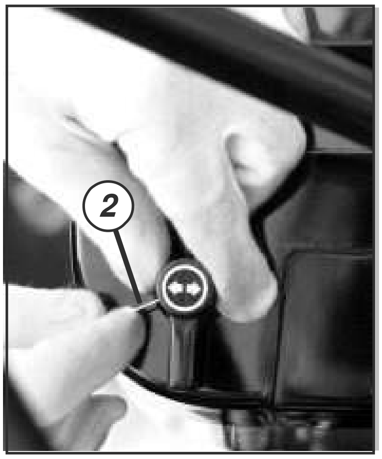


Fig 19

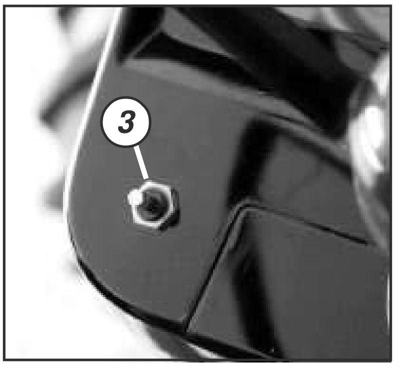


Fig 20

14 A . 20 Air cleaner restriction sensor

If the restriction sensor fails to operate (warning light does not light up, even with a clogged air cleaner), first of all, ensure that the problem is not the warning light bulb, or in any disconnected wire. For this operation, turn the ignition key to the 2nd position with engine not running. If the warning light, lights up, the problem lies in the sensor itself.

Carry out the test by adhering to the following practices:

a) Pull the hood latch cable and lift the hood to access vaccum switch.

b) Run the engine and keep it at 1000/1200 rpm.

c) Cover the air cleaner inlet (5A) with a metal plate or a piece of flat wood for a brief period, then check if the warning light (5C) on the instrument panel: it should light up. If it does not, replace the sensor (5B).

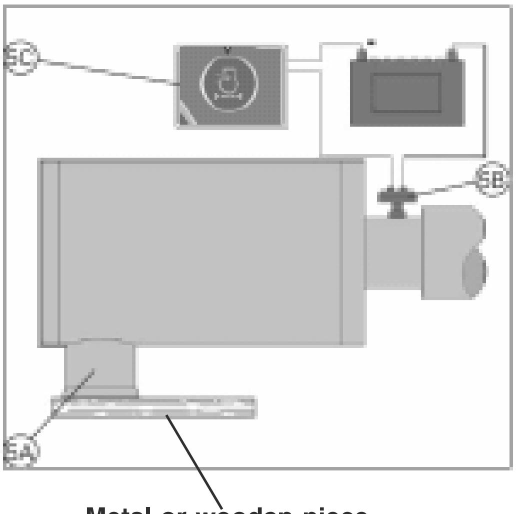


Fig 21

14 A . 21 TRAILER SOCKET

Removal and refitment

Removal

1. Disconnect the battery, removing the negative cable (-) first in the interest of safety.
2. Remove the two screws, nuts and washers.
3. Pull the socket and connecting wire away from the mounting bracket, allowing the connecting wire retaining screws to be slackened, so releasing the connecting wire. Do not over strain the wire loom.
4. Check for wear, damage or corrosion and replace the socket with a new one if necessary.

Refitment

5. Reverse procedures 1 to 4.

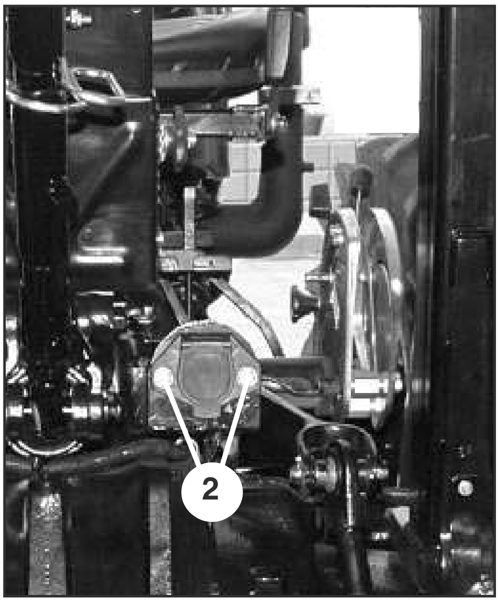


Fig 21

14 A . 22 FUSES AND RELAYS

Check

Fuses and relays are situated in five places as follows:

- Console fuse panel under the steering wheel.
- Behind the instrument panel - relays only.

  The fuses installed in the fuse boxes and relays will depend upon the model specification.

Fuses :

1 The fuses are located in behind the fuel filter.

2 The cover (A) holds the spare fuse in different different fuse ratings.

3 primary fuse (B) for over all protection of the electrical system.

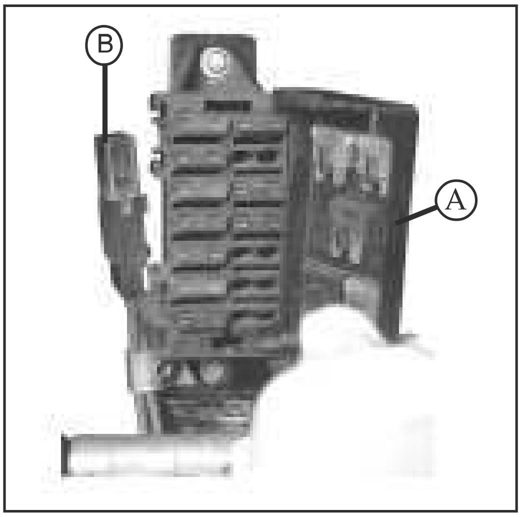


Fig 22

Fuses:

Removal and refitment

Removal:

1. Pull the hood latch cable and lift the hood.
2. Disconnect the battery terminal for your interest of safety.
3. Press and pull to remove the fuse box cover to access the fuses.
4. Remove the failured fuse.

Replacement:

5. Reverse the procedure 1 to 4 .except
   a.replace the failured fuse by new one.

Fuse ratings and color identification

The fuses are specified in different ratings and color for different application and easy identification.The fuse color and ratings are specified as follows.

Ratings (amps)	Identification colors
5	Tan
10	Red
15	Blue
25	Natural white

14 A . 23 Arrangement of fuse in fuse box for MF2615 (2WD/4WD)

1. FOR TRACTOR WITH

LIVE PTO

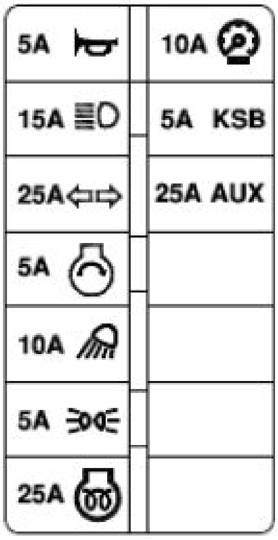

5A
10A
15A
5A KSB
25A
25A AUX
5A
10A
5A
25A

Fig 23

2. FOR TRACTOR WITH

IPTO

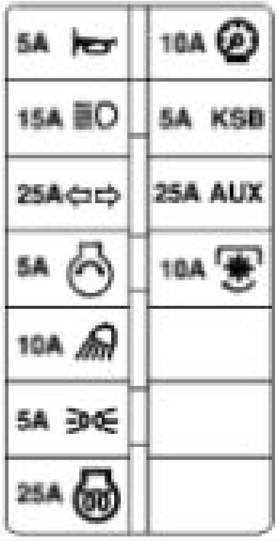

5A
10A
15A
5A KSB
25A
25A AUX
5A
10A
10A
5A
25A

Fig 24

KEY TO SYMBOLS

📯 → Horn

≣D → Head lamps

⇦⇨ → Flashing light

○ → Start

○ → Work lamp

⋺⋲ → Tail lamp

○ → Heater

○ → Instrument cluster

KSB → KSB circuit

AUX → Auxiliary power

✱ → I - PTO

14 A . 24 Arrangement of fuse in fuse box for MF 2605 (2WD/4WD):

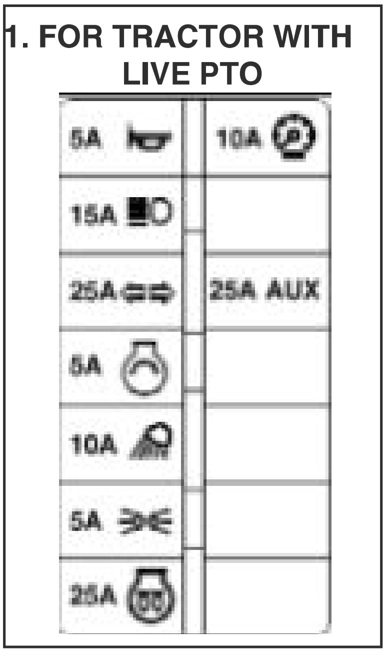

1. FOR TRACTOR WITH LIVE PTO
5A
10A
15A
25A
25A AUX
5A
10A
5A
25A

Fig 25

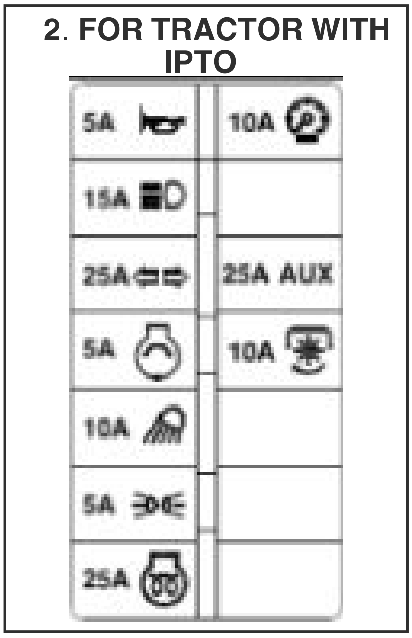

2. FOR TRACTOR WITH IPTO
5A
10A
15A
25A
25A AUX
5A
10A
10A
5A
25A

Fig 26

KEY TO SYMBOLS

→ Horn

→ Head lamps

⇦⇨ → Flashing light

→ Start

→ Work lamp

→ Tail lamp

→ Heater

→ Instrument cluster

KSB → KSB circuit

AUX → Auxiliary power

→ I - PTO

14 A . 25 RELAYS

Removal and Refitment

Test Equipment: MF.3005 Digital Multimeter

Electrical relays are provided in the following services:

1) Head lamp main beam.
2) Head lamp low beam.
3) Amber flashing light (Hazard).
4) Red flashing lights (Turn).
5) KSB solenoid - For MF2615 Only.

The illustration shows the relay used on the tractor, the pin layout, terminal numbers, electrical schematic, switch and coil connections.

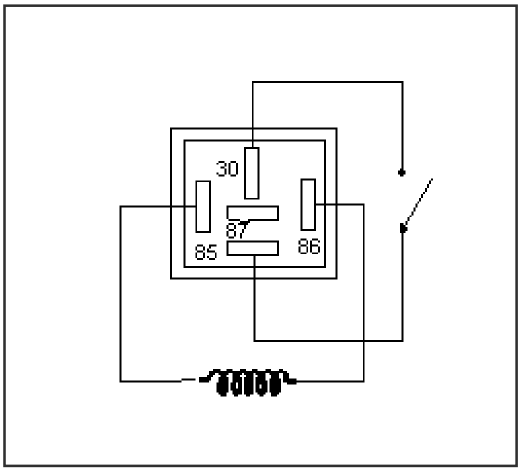


Fig 27

Removal

1. Access and remove the suspect relay.
2. Test the coil between terminals 85 and 86 with the MF.3005 Digital Multimeter set on ohms.
3. The reading should be approximately 65 ohms.
4. Terminals 30 and 87 is the switch which is normally open, closed when the coil is energised.

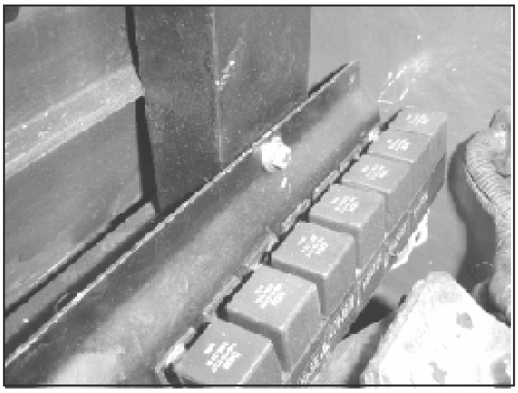


Fig 28

14 A . 26 Instrument cluster

The instrument panel has a number of displays and warning lights as follows:

5. Engine RPM meter - Showing engine speed.
14. Hour meter - Showing No.of houre run by tractor (Real hour - irrespective of engine speed)
10. Fuel guage - Shows the fuel level in the tank.
9. Temperture guage - Shows the temperature of the coolant in the engine.
1. Engine oil pressure guage - Shows the pressure developed in engine oil pump.
18. Voltmeter - Shows the battery voltage.

Instrument warning light - Shows warning indication in the cluster or indication of engaged services.The lights are as follow

From left hand side.

2. Left hand turn signal indicator light.
3. Turn signal indicator light 1st trailor.
4. Head light high beam light.
15. Low engine oil pressure indicator light.
16. Battery charge indicator light.
17. 4WD drive indicator light.(If provided).

From right hand side:

6. IPTO indicator light.(If provided).
7. Air filter restriction indicator light.
8. Right hand turn signal indicator light.
9. Engine coolant high temperature warning light.
11. Not used.
12. Not used.

Various sender units are used to control the instruments as follows:

Oil pressure switch - Engine oil pressure
Vacuum switch - Air filter restiction.
Fuel sensor - Fuel level in the tank.
Temperature sensor resistor - engine coolant.

The wiring to all electrical services is an earth / ground return system, the earth wire (-) is colour coded black and is connected to the chassis at various point around the tractor.

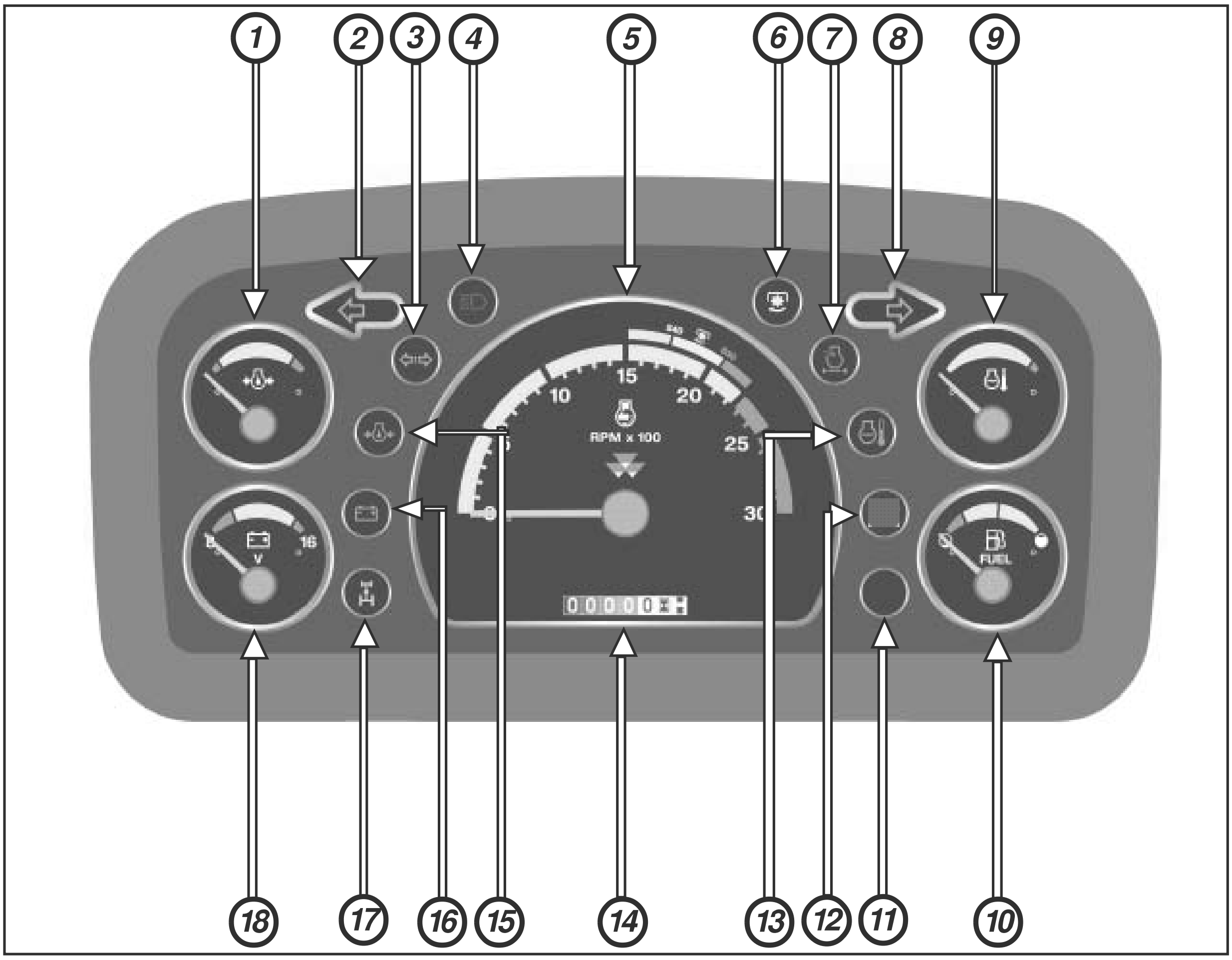


Fig 29

1. Engine oil pressure gauge
2 . Left-hand turn signal indicator light
3. Turn signal indicator light 1st trailer
4. Head light high beam light
5. Engine RPM meter
6. IPTO indicator light (If provided)
7. Air filter restriction indicator light
8. Right-hand turn signal indicator light
9. Engine coolant temperature gauge
10. Fuel gauge
11. Not used
12. Not used
13. Engine coolant high temperature warning light
14. Hour meter
15. Low engine oil pressure indicator light
16. Battery charge indicator light
17. 4WD indicator light (If provided)
18. Voltmeter

14 A . 27 Instrument cluster

Removal and Refitment:

Removal

1. Pull the hood latch cable and lift the hood.
2. Disconnect the battery terminals.
3. Remove the bottom surround mounting screws.
4. Remove the top surround mounting screws.
5. Disconnect the wiring harness from the cluster.
6. Place the cluster with surround in scratch free area and remove the six mounting screws.

Refitment:

7. Reverse the procedure 1 to 6.except
   a.Ensure that the wiring harness connectors and connector cover are correctly fitted in the back of the instrument cluster.

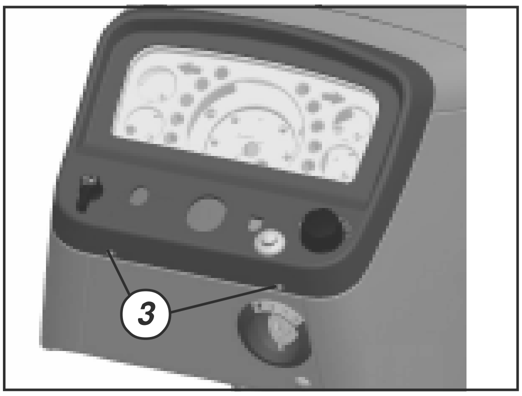


Fig 30

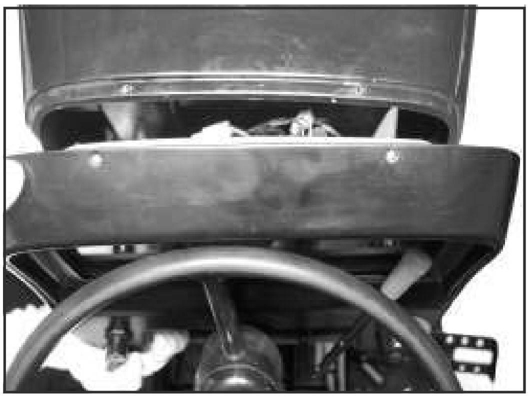


Fig 31

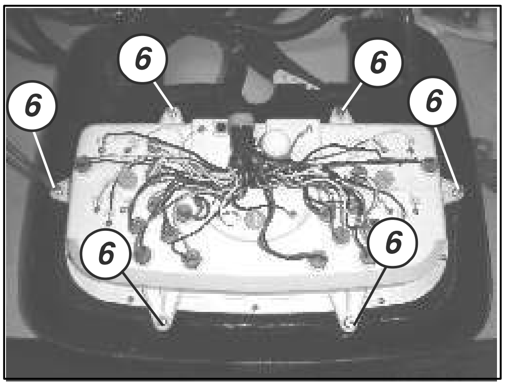


Fig 32

14 A . 28 INSTRUMENT CLUSTER

Overhaul

Precautions to be taken care while replacing :

Procedure for replacing:

Keep the instruments cluster in facing down on a *"clean"*and *"scratch free"* surface.

1. Remove the cluster from the tractor.

   a. Carefully remove the (10) self-tapping screws that are used to fix the front cover to the rear case.

   b. Reverse the instrument cluster and take away the front cover,glass with sealing ring assembly and front dial and keep it on the scartch free surface in the dust free area / enviroment .

Instrument cluster consists of the following.

1.Electronic hour RPM meter.
2.Fuel gauge
3.Temperature gauge
4.Pressure gauge
5.Voltmeter
6.Symbol sheets (2- nos)

c.Electronic hour RPM meter consists of

- Assy PCB rigid.
- Assy RPM system with hour meter.

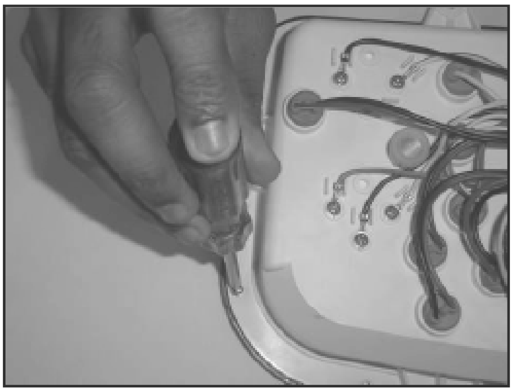


Fig 33

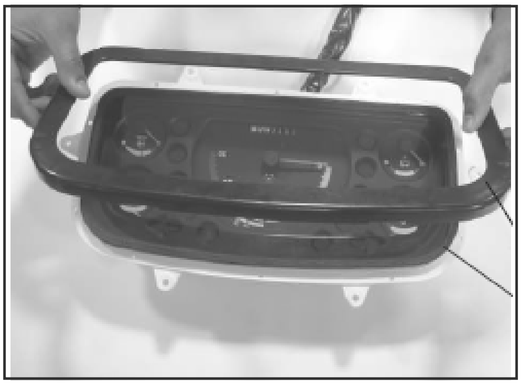


Fig 34

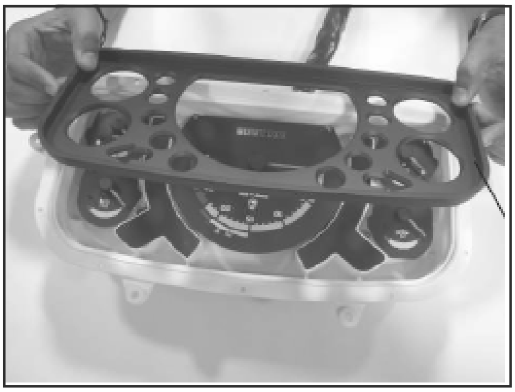


Fig 35

Electronic hour counter RPM meter

Removal of Assy RPM with hour meter:

1. Remove the cluster from tractor and keep the cluster facing down on scartch free surface.
2. Remove the six screws,spring washer and plain washer.
3. Remove the slot nut and washer.
4. Remove the rpm meter from the cluster.

Refitment :

5. Reverse the procedure 1 to 3 except
   a. Tighten the all screws at the torque of 1.5 kgf - cm (1.2 lbf.inch) minimum can be applied.
   b. Ensure proper seating of screws.

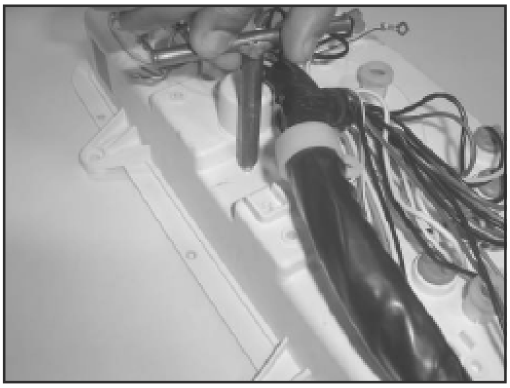


Fig 36

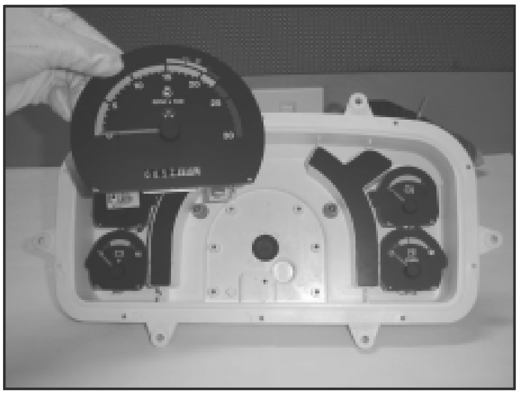


Fig 37

Assy PCB rigid:

Removal:

1. Remove the cluster from tractor and keep the cluster facing down on scartch free surface.
2. Remove the four screws ,from the RPM meter.
3. Remove the assy PCB rigid from the assy RPM meter.

Refitment :

4. Reverse the procedure 1 to 3 except
   a. Tighten the four screws at the torque of 3.5 kgf - cm - 7 kgf/cm (3 - 6 lbf.inch) minimum can be applied.
   b. Ensure proper seating of screws and gauges.

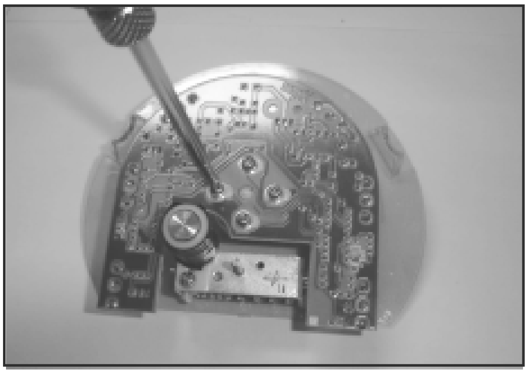


Fig 38

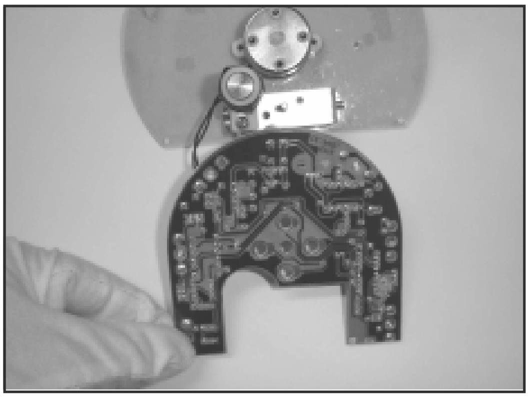


Fig 39

Fuel Gauge:

Removal :

1. Remove the cluster from tractor and keep the cluster facing down on scartch free surface.
2. Remove the three screws , spring washer from the fuel gauge system.
3. Remove the fuel gauge from the instrument cluster.

Refitment :

4. Reverse the procedure 1 and 3 except
   a. Tighten the three screws at the torque of 1.5 kgf/cm (1.2 lbf.inch) minimum can be applied.
   b. Ensure proper seating of screws and gauges.

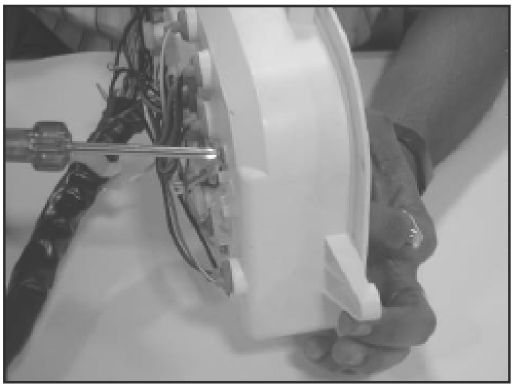


Fig 40

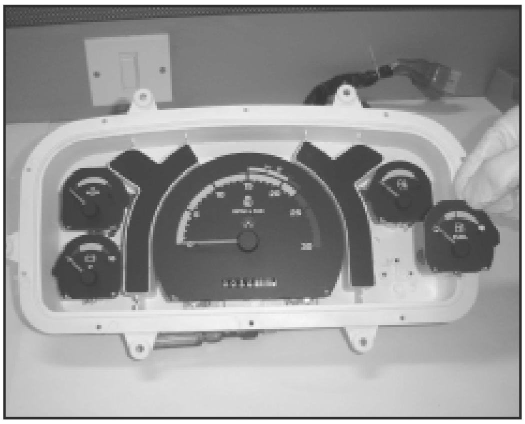


Fig 41

Temperature Gauge:

Removal:

1. Remove the cluster from tractor and keep the cluster facing down on scartch free surface.
2. Remove the three screws , spring washer from the temperature gauge system.
3. Remove the temperature gauge from the instument cluster.

Refitment :

4. Reverse the procedure 1 and 3 except
   a. Tighten the three screws at the torque of 1.5 kgf/cm (1.2 lbf.inch)minimum can be applied.
   b. Ensure proper seating of screws and gauges.

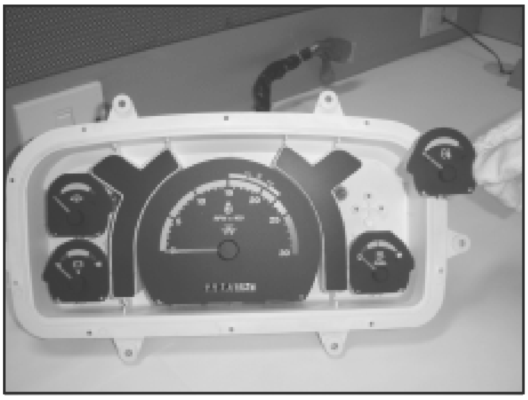


Fig 42

Pressure Gauge:

Removal:

1. Remove the cluster from tractor and keep the cluster facing down on scartch free surface.
2. Remove the three screws , spring washer from the oil pressure guage.
3. Remove the oil pressure gauge from the instrument cluster.

Refitment

4. Reverse the procedure 1 and 3 except
   a. Tighten the three screws at the torque of 1.5 kgf- cm (1.2 lbf.inch) minimum can be ap plied.
   b. Ensure proper seating of screws and gauges.

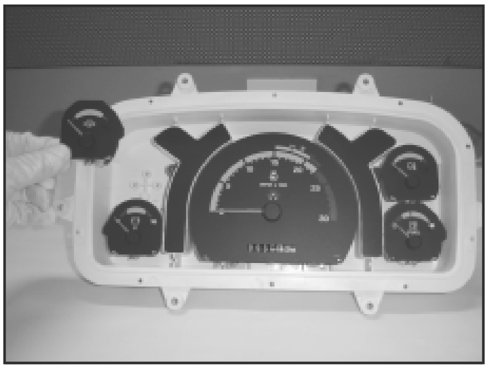


Fig 43

Voltmeter

Removal:

1. Remove the cluster from tractor and keep the cluster facing down on scartch free surface.
2. Remove the two screws , spring washer from the instrument cluster.
3. Remove the voltmeter from the instrument cluster.

Refitment :

4. Reverse the procedure 1 and 3 except
   a. Tighten the six screws at the torque of 1.5 kgf - cm (1.2 lbf.inch.)minimum can be applied.
   b. Ensure proper seating of screws and gauges.

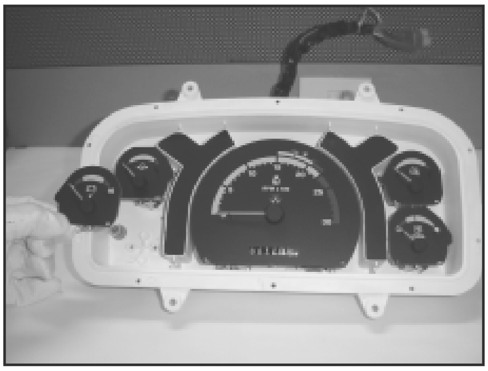


Fig 44

Instrument Cluster Blub

Removal and refitment

Removal

1. Pull the bulb and its holder from the instrument cluster and remove the bulb from the holder.

Refitment

2. Fit the bulb in its holder.
3. Push the bulb holder and bulb into the instrument.

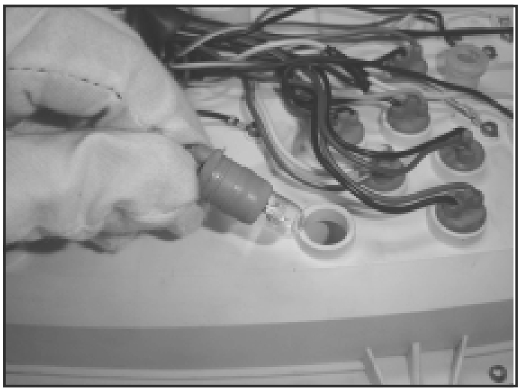


Fig 45

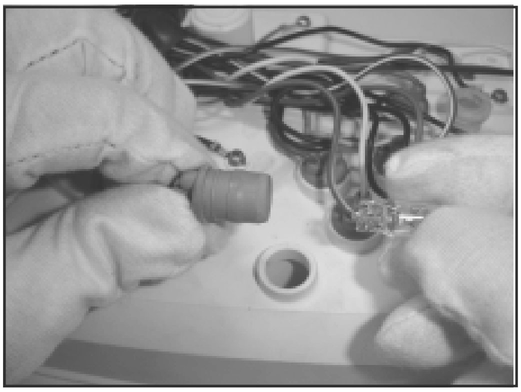


Fig 46

Assy.Wiring harness:

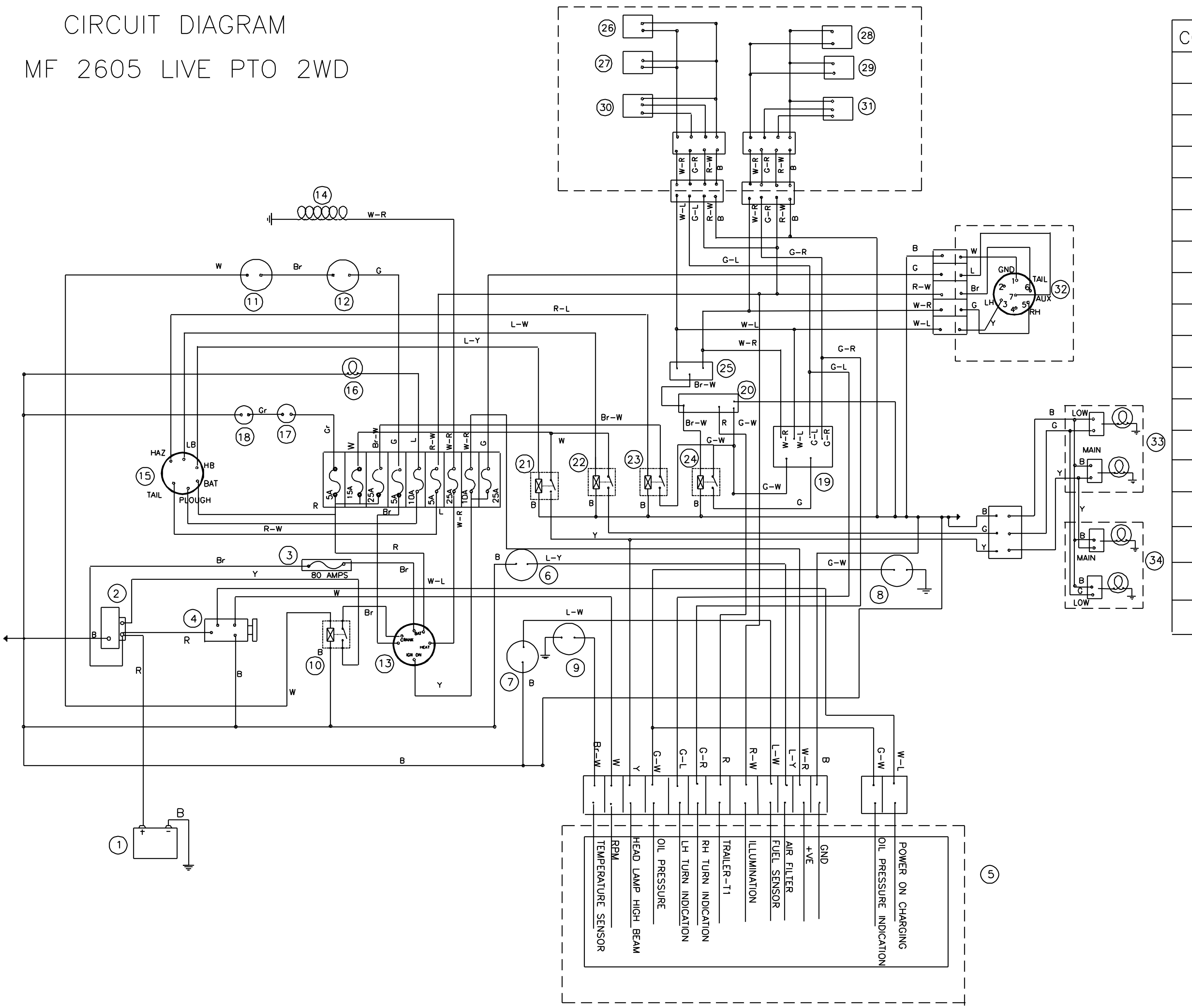
Removal

1. Remove the cluster from the tractor.
2. Remove the self tapping screws carefully , which is used in assy wiring harness in the case with clip.

Refitment:

3. Reverse the procedure 1 to 2 except
   a.tighten the screws with the torque of 1.5 kgf - cm (1.2 lbf.inch.) minimum can be applied and ensure proper seating of screws.

CIRCUIT DIAGRAM
MF 2605 LIVE PTO 2WD



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IGN ON
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LOW
MAIN
5A
15A
25A
10A
TEMPERATURE SENSOR
RPM
HEAD LAMP HIGH BEAM
OIL PRESSURE
LH TURN INDICATION
RH TURN INDICATION
TRAILER-T1
ILLUMINATION
FUEL SENSOR
AIR FILTER
+VE
GND
OIL PRESSURE INDICATION
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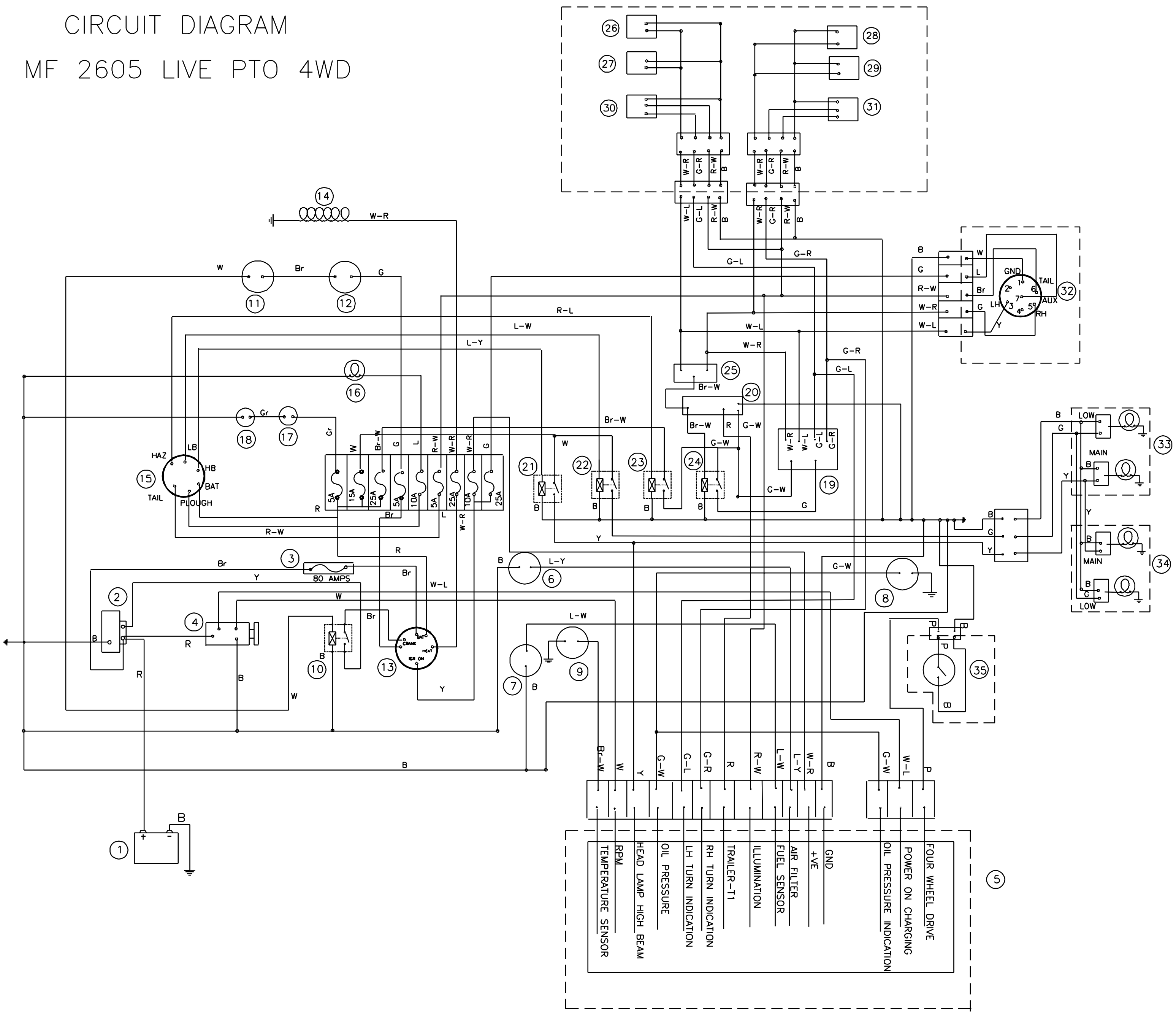
R-L
G-R
G-W
Br-W

COLOUR CODE DETAILS

COLOUR CODE	COLOUR
B	BLACK
R	RED
Y	YELLOW
W	WHITE
G	GREEN
P	PINK
L	BLUE
Br	BROWN
Gr	GRAY
L-Y	BLUE YELLOW
R-W	RED WHITE
G-L	GREEN BLUE
W-R	WHITE RED
W-L	WHITE BLUE
L-W	BLUE WHITE
R-L	RED BLUE
G-W	GREEN WHITE
Br-W	BROWN WHITE

CIRCUIT DIAGRAM

MF 2605 LIVE PTO 4WD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10A
FOUR WHEEL DRIVE
POWER ON CHARGING
OIL PRESSURE INDICATION
GND
+VE
AIR FILTER
FUEL SENSOR
ILLUMINATION
TRAILER-T1
RH TURN INDICATION
LH TURN INDICATION
OIL PRESSURE
HEAD LAMP HIGH BEAM
RPM
TEMPERATURE SENSOR
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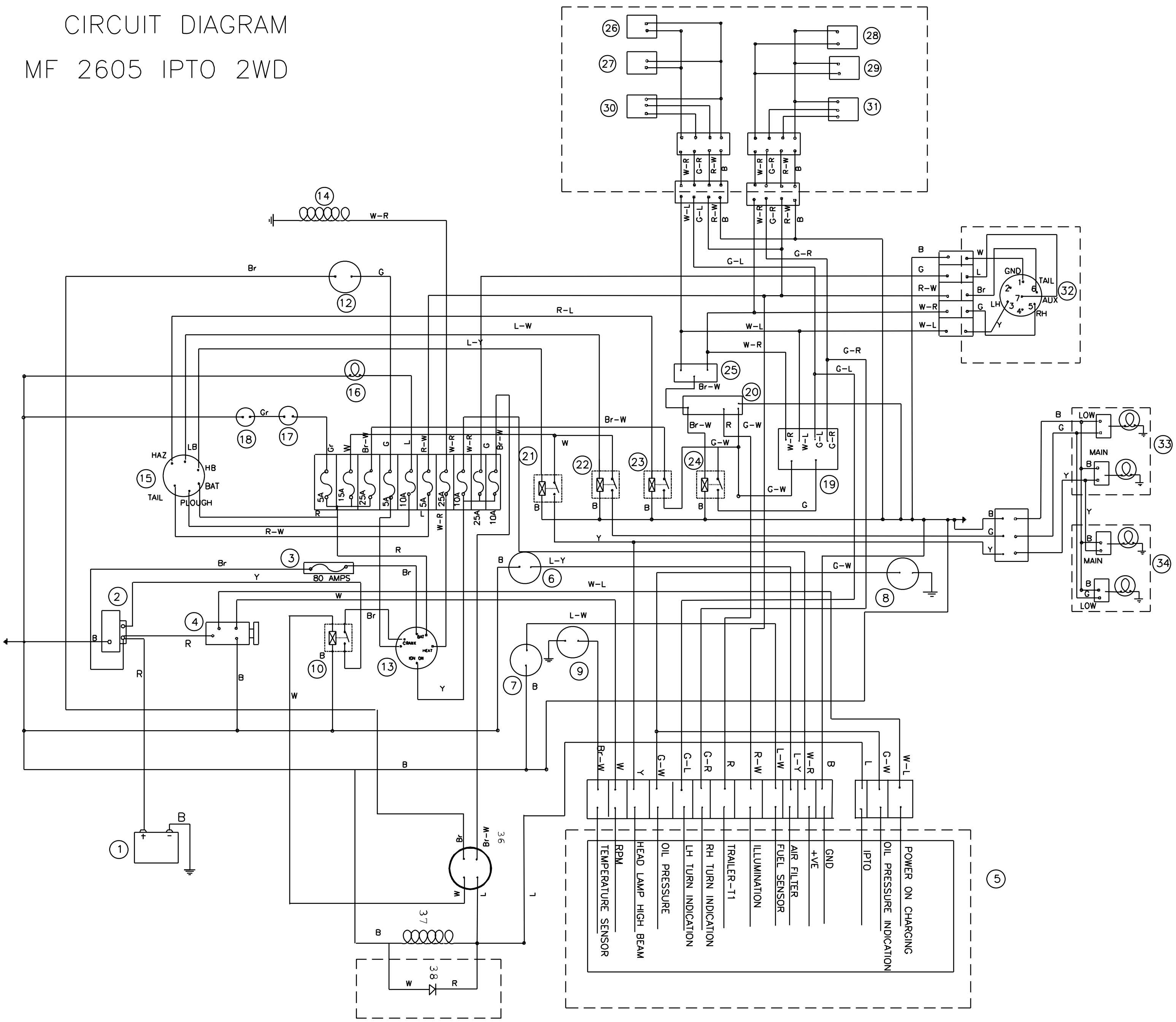
COLOUR CODE DETAILS

COLOUR CODE	COLOUR
B	BLACK
R	RED
Y	YELLOW
W	WHITE
G	GREEN
P	PINK
L	BLUE
Br	BROWN
Gr	GRAY
L-Y	BLUE YELLOW
R-W	RED WHITE
G-L	GREEN BLUE
W-R	WHITE RED
W-L	WHITE BLUE
L-W	BLUE WHITE
R-L	RED BLUE
G-W	GREEN WHITE
Br-W	BROWN WHITE

CIRCUIT DIAGRAM
MF 2605 IPTO 2WD



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OIL PRESSURE INDICATION
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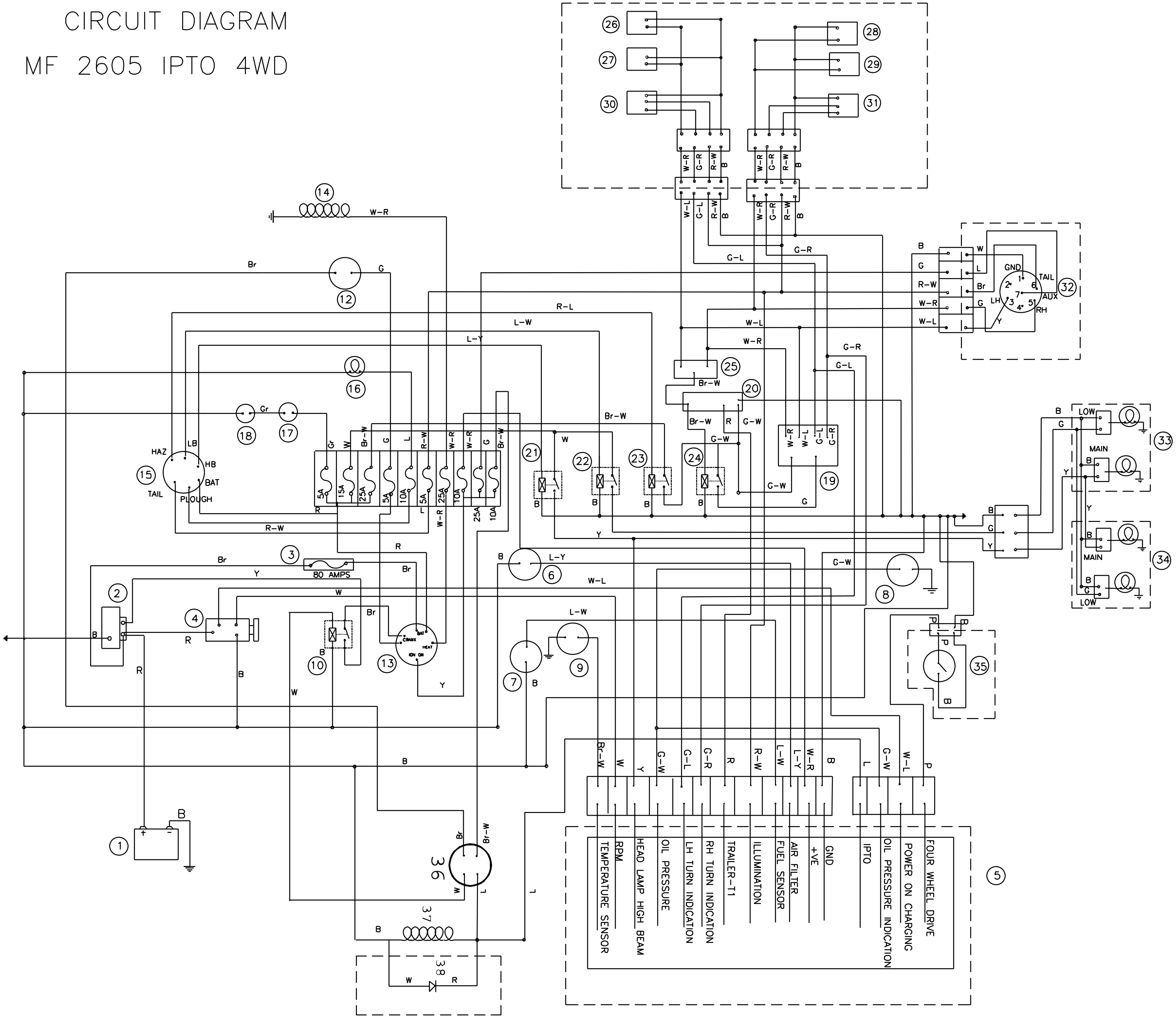
AIR FILTER
FUEL SENSOR
ILLUMINATION
TRAILER-T1
RH TURN INDICATION
LH TURN INDICATION
OIL PRESSURE
HEAD LAMP HIGH BEAM
RPM
TEMPERATURE SENSOR

COLOUR CODE DETAILS

COLOUR CODE	COLOUR
B	BLACK
R	RED
Y	YELLOW
W	WHITE
G	GREEN
P	PINK
L	BLUE
Br	BROWN
Gr	GRAY
L–Y	BLUE YELLOW
R–W	RED WHITE
G–L	GREEN BLUE
W–R	WHITE RED
W–L	WHITE BLUE
L–W	BLUE WHITE
R–L	RED BLUE
G–W	GREEN WHITE
Br–W	BROWN WHITE

CIRCUIT DIAGRAM
MF 2605 IPTO 4WD



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FOUR WHEEL DRIVE
POWER ON CHARGING
OIL PRESSURE INDICATION
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AIR FILTER
FUEL SENSOR
ILLUMINATION
TRAILER-T1
RH TURN INDICATION
LH TURN INDICATION
OIL PRESSURE
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RPM
TEMPERATURE SENSOR
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CRANK HEAT IGN ON BAT

COLOUR CODE DETAILS

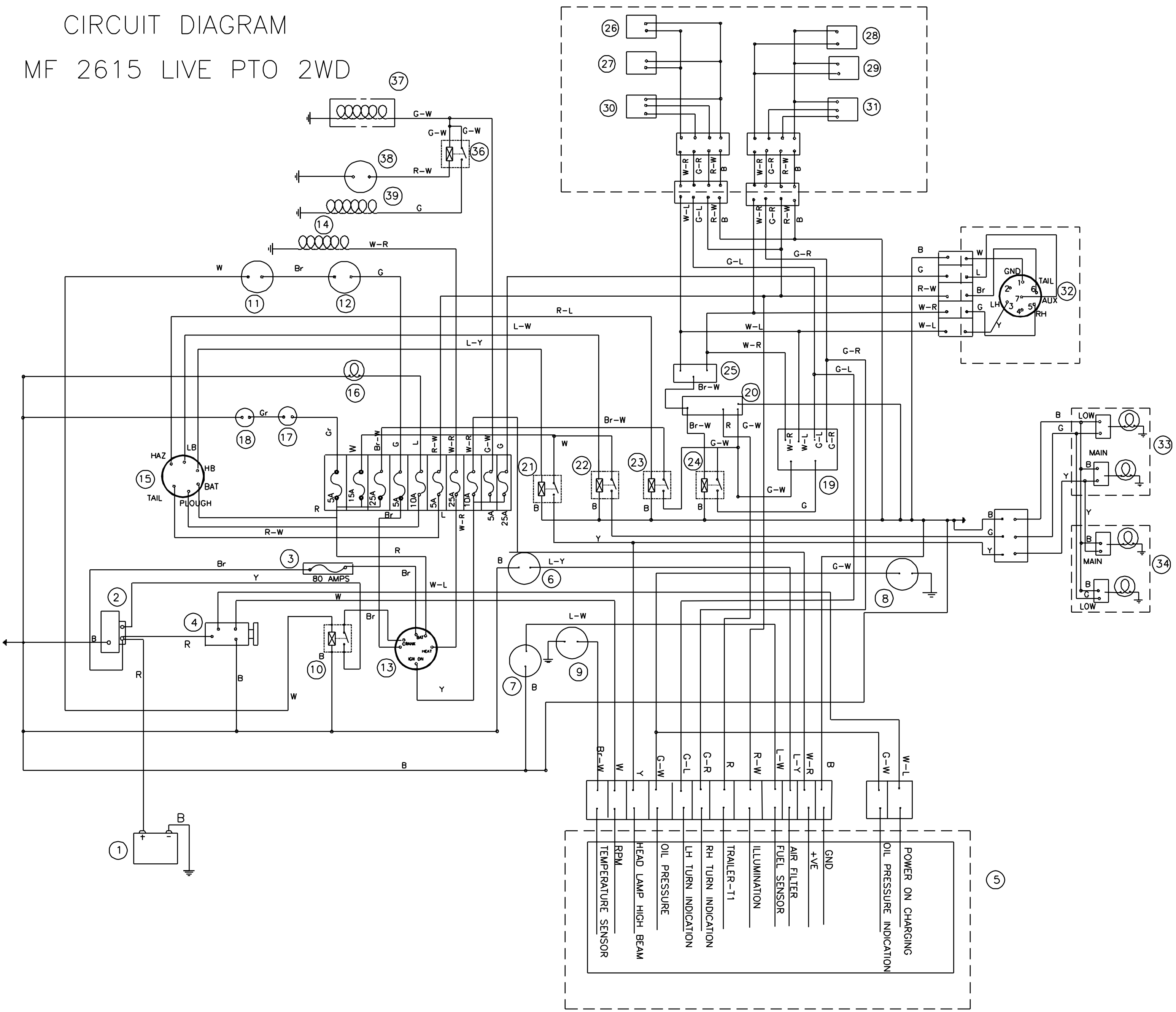
COLOUR CODE	COLOUR
B	BLACK
R	RED
Y	YELLOW
W	WHITE
G	GREEN
P	PINK
L	BLUE
Br	BROWN
Gr	GRAY
L–Y	BLUE YELLOW
R–W	RED WHITE
G–L	GREEN BLUE
W–R	WHITE RED
W–L	WHITE BLUE
L–W	BLUE WHITE
R–L	RED BLUE
G–W	GREEN WHITE
Br–W	BROWN WHITE

Key to wiring diagram MF 2605

1	Battery
2	Starter motor
3	Primary fuse
4	Alternator
5	Instrument cluster
6	Air restriction switch
7	Fuel sensor
8	Oil pressure switch
9	Temperature sensor
10	Starter relay
11	PTO switch
12	neutral start switch
13	Ignition switch
14	Heater
15	Light switch
16	Work lamp
17	Horn
18	Horn switch
19	Turn indicator switch
20	Flasher
21	Head lamp main beam relay
22	Head lamp dip beam relay
23	Hazard relay
24	Turn lights(red) relay
25	CA diode module
26	Amper flashing lamp-left - hand front
27	Amper flashing lamp- left -hand rear
28	Amper flashing lamp- right - hand front
29	Amper flashing lamp- right - hand rear
30	Red lamp- left - hand
31	Red lamp- right - hand
32	Trailer socket
33	Head lamp- right - hand
34	Head lamp- left - hand
35	4 Wheel drive switch
36	IPTO switch
37	IPTO solenoid
38	Diode

CIRCUIT DIAGRAM

MF 2615 LIVE PTO 2WD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LH TURN INDICATION
RH TURN INDICATION
TRAILER-T1
ILLUMINATION
FUEL SENSOR
AIR FILTER
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OIL PRESSURE INDICATION
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G-R
Br-W

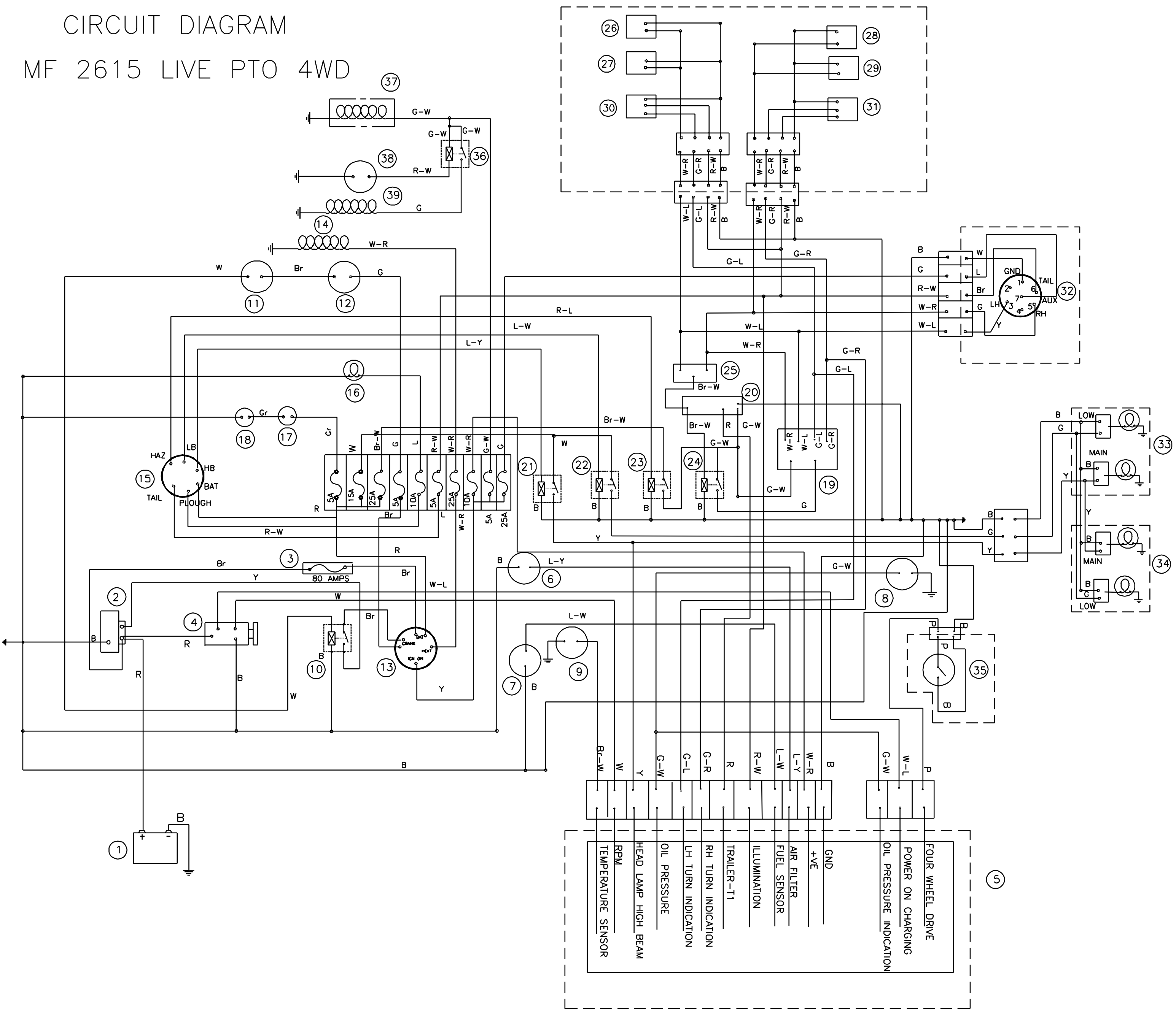
COLOUR CODE DETAILS

COLOUR CODE	COLOUR
B	BLACK
R	RED
Y	YELLOW
W	WHITE
G	GREEN
P	PINK
L	BLUE
Br	BROWN
Gr	GRAY
L-Y	BLUE YELLOW
R-W	RED WHITE
G-L	GREEN BLUE
W-R	WHITE RED
W-L	WHITE BLUE
L-W	BLUE WHITE
R-L	RED BLUE
G-W	GREEN WHITE
Br-W	BROWN WHITE

AGCO

CIRCUIT DIAGRAM

MF 2615 LIVE PTO 4WD



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G-R
FOUR WHEEL DRIVE
POWER ON CHARGING
OIL PRESSURE INDICATION
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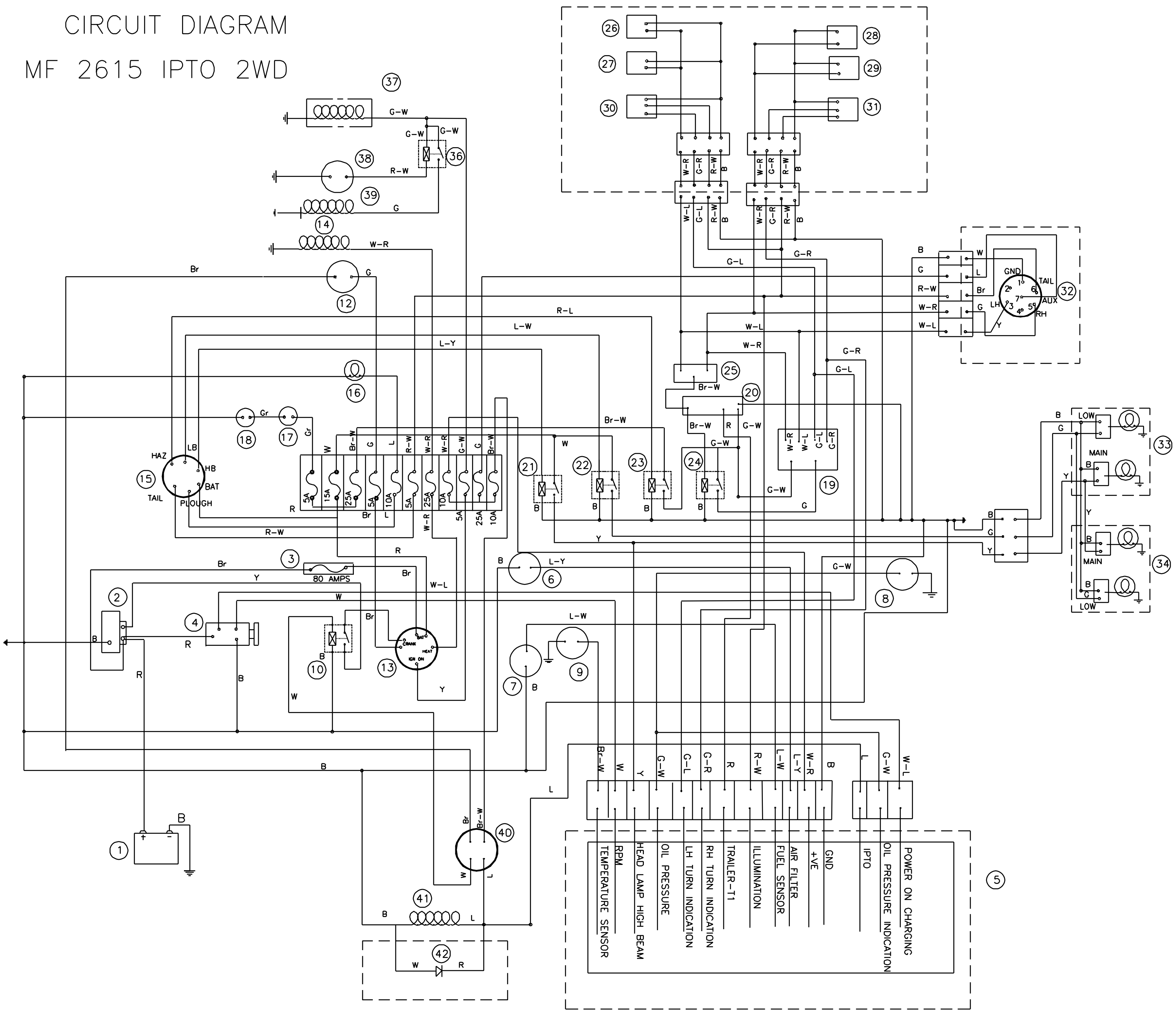
AIR FILTER
FUEL SENSOR
ILLUMINATION
TRAILER-T1
RH TURN INDICATION
LH TURN INDICATION
OIL PRESSURE
HEAD LAMP HIGH BEAM
RPM
TEMPERATURE SENSOR

COLOUR CODE DETAILS

COLOUR CODE	COLOUR
B	BLACK
R	RED
Y	YELLOW
W	WHITE
G	GREEN
P	PINK
L	BLUE
Br	BROWN
Gr	GRAY
L-Y	BLUE YELLOW
R-W	RED WHITE
G-L	GREEN BLUE
W-R	WHITE RED
W-L	WHITE BLUE
L-W	BLUE WHITE
R-L	RED BLUE
G-W	GREEN WHITE
Br-W	BROWN WHITE

CIRCUIT DIAGRAM
MF 2615 IPTO 2WD



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OIL PRESSURE INDICATION
IPTO
GND
+VE
AIR FILTER
FUEL SENSOR
ILLUMINATION
TRAILER-T1
RH TURN INDICATION
LH TURN INDICATION
OIL PRESSURE
HEAD LAMP HIGH BEAM
RPM
TEMPERATURE SENSOR
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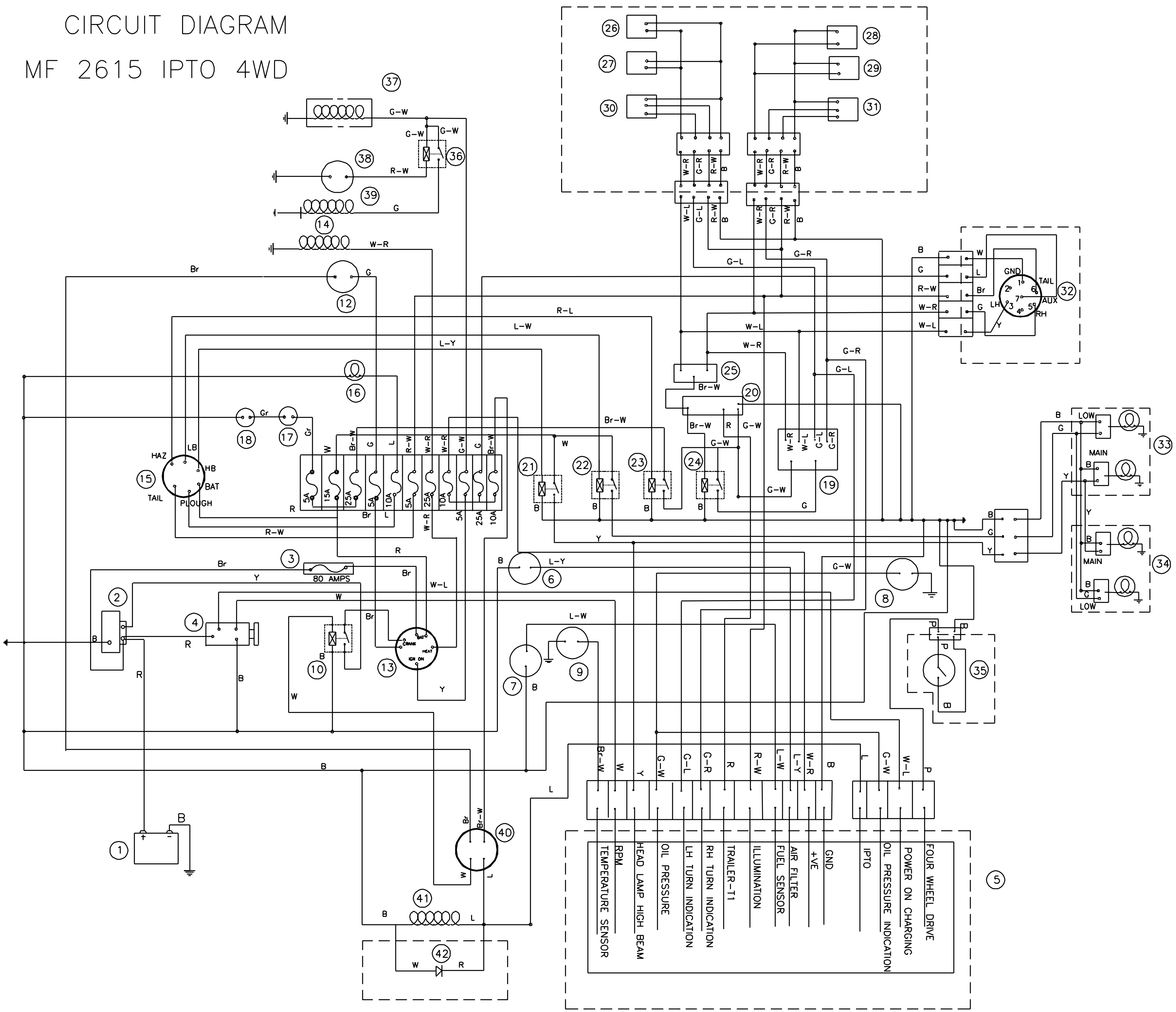
COLOUR CODE DETAILS

COLOUR CODE	COLOUR
B	BLACK
R	RED
Y	YELLOW
W	WHITE
G	GREEN
P	PINK
L	BLUE
Br	BROWN
Gr	GRAY
L–Y	BLUE YELLOW
R–W	RED WHITE
G–L	GREEN BLUE
W–R	WHITE RED
W–L	WHITE BLUE
L–W	BLUE WHITE
R–L	RED BLUE
G–W	GREEN WHITE
Br–W	BROWN WHITE

CIRCUIT DIAGRAM
MF 2615 IPTO 4WD



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80 AMPS
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FOUR WHEEL DRIVE
POWER ON CHARGING
OIL PRESSURE INDICATION
IPTO
GND
+VE
AIR FILTER
FUEL SENSOR
ILLUMINATION
TRAILER-T1
RH TURN INDICATION
LH TURN INDICATION
OIL PRESSURE
HEAD LAMP HIGH BEAM
RPM
TEMPERATURE SENSOR
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COLOUR CODE DETAILS

COLOUR CODE	COLOUR
B	BLACK
R	RED
Y	YELLOW
W	WHITE
G	GREEN
P	PINK
L	BLUE
Br	BROWN
Gr	GRAY
L-Y	BLUE YELLOW
R-W	RED WHITE
G-L	GREEN BLUE
W-R	WHITE RED
W-L	WHITE BLUE
L-W	BLUE WHITE
R-L	RED BLUE
G-W	GREEN WHITE
Br-W	BROWN WHITE

Key to wiring diagram MF 2615

1	Battery
2	Starter motor
3	Primary fuse
4	Alternator
5	Instrument cluster
6	Air restriction switch
7	Fuel sensor
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11	PTO switch
12	Neutral start switch
13	Ignition switch
14	Heater
15	Light switch
16	Work lamp
17	Horn
18	Horn switch
19	Turn indicator switch
20	Flasher
21	Head lamp main beam relay
22	Head lamp dip beam relay
23	Hazard relay
24	Turn lights(red) relay
25	CA diode module
26	Amper flashing lamp-left - hand front
27	Amper flashing lamp-left - hand rear
28	Amper flashing lamp-right - hand front
29	Amper flashing lamp-right - hand rear
30	Red lamp-left - hand
31	Red lamp-right - hand
32	Trailer socket
33	Head lamp-right - hand
34	Head lamp-left - hand
35	4 Wheel drive switch
36	KSB relay
37	Rotary pump
38	KSB switch
39	KSB solenoid
40	IPTO switch
41	IPTO solenoid
42	Diode

14 A . 30 FAULT FINDING CHART :

Symptoms	Probable chart		Test procedure	Remedial action
	Alternator	Circuit		
Indicator light stays out under all condition	---	Blown fitment	---	Renew filament
	Internal short circuit	---	Max output (low reading)	Change alternator rectifier
	---	Bad connection or broken cable	Continuity test	Renew connections / cable
Indicator light stays on under all conditions (dims at low rev/min)	High output (internal short circuit)	---	MAX. output test voltage regulator test	Change alternator rectifier / Voltage Regulator
Indicator light stays on .Dims as rev/min increases: goes out at high rev/min	---	Short circuit earth	Continuity test / Voltage drop test	Renew cable/connection
	---	Fan belt adjustment	---	Adjust fan belt
	Output low	---	Max.output test	Change alternator / Voltage Regulator
Battery not charging	---	Battery in poor condition	Hydrometer test / Discharge test	Change battery
	Voltage control faulty	---	Voltage regulator test	Change alternator / Voltage Regulator
	---	High resistance (Bad connections lead to earth)	Continuity test / Voltage drop test	Renew or clean connection
Battery over charging (excessive use of electrolyte, filament bulbs blow after short period in service	Voltage control	---	Voltage regulator test	Change alternator / Voltage Regulator
Light ON when engine stationary .Dims at cut in speed and remains dim at very high speeds.	Internal short circuit	---	Max.output (very low)	Change alternator rectifier

SECTION 14

STARTER MOTOR

Part B

Table of contents

Operation No.	Description		Page No.
14B . 1	Specification	...	14B - 2
14B . 2	General description	...	14B - 2
14B . 3	Starter motor - Introduction	...	14B - 3
14B . 4	Starter motor testing - check	...	14B - 3
14B . 5	Transmission Neutral start switch - removal	...	14B - 6
14B . 6	PTO Neutral start switch - removal	...	14B - 6
14B . 7	Starter motor - removal	...	14B - 7

14B .1 SPECIFICATION:

Voltage	12 volt negative ground

Starter motor

Make	LUCAS - TVS

Model

Normal duty - 2600 Series tractors....................................	3SM114
Voltage	12 volt
Type...	Pre-engaged

Bolt torques

Starter motor terminals - M8	62 lbf.inch (7 Nm).

14B . 2 GENERAL DESCRIPTION

The electrical system for the 2600 series tractor is 12 volt negative ground. The starter motor is mounted on the right-hand side of the 3 cylinder engine tractors. A neutral start switch is fitted on the top of the transmission and on the PTO control lever. This renders the starter motor inoperative until the dual range selector lever is in the neutral position and the PTO lever/switch is in the disengaged position. A relay controls the supply to the starter solenoid to prevent voltage drop.

14B .3 STARTER MOTOR

Introduction:-

The starter is a motor which converts electrical energy, supplied from the battery, into mechanical energy for the purpose of cranking the engine.

The 2600 series tractor uses the pre-engaged type which is fitted with a solenoid which engages the starter pinion with the flywheel ring gear before the starter is energised. After engagement the pinion is retained in mesh for as long as is necessary to start the engine. When the engine is firing and the pinion is being driven at high speed by the flywheel, the armature is protected against over-speeding by the flywheel action of an inbuilt clutch.

In the event of a problem with the starter motor or circuit the following procedure should be adopted:

14B .4 Starter motor testing

TEST 1-Checking battery condition (Fig. 1)

Take the hydrometer reading of the battery cells to establish the state of the charge.

Diagnosis

Result	Action
Reading below 1.230	Recharge the battery or replace and retest
Reading 1.230 - 1.290	Proceed to test 2

Alternative test (Fig. 2)

Measure the open circuit voltage of the battery with the MF.3005 Digital Multimeter to establish the state of the charge.

Result	Action
12 Volts	Discharged battery - Recharge
12.4 Volts	50 % charge - recharge
12.7 + Volts	Fully charged

TEST 2 - Checking connections

Check that all battery, ground, starter motor and solenoid connections are clean and tight

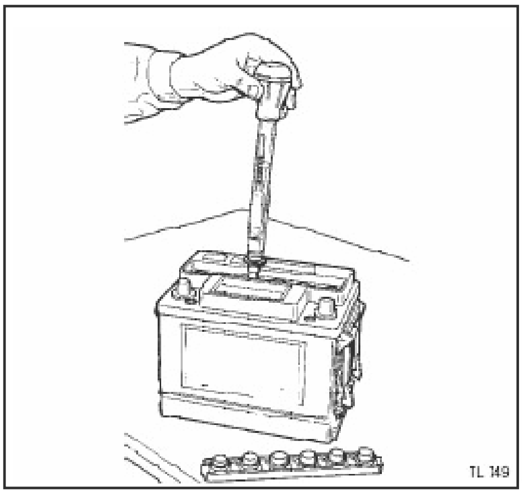

Fig 1

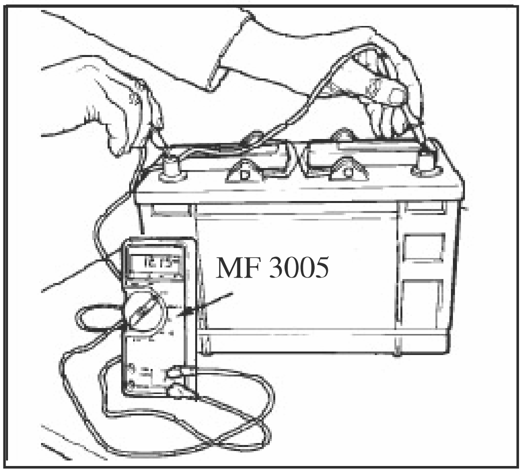

Fig 2

Diagnosis:

Result	Action
Loose and /or dirty	Rectify
Statisfactory	Proceed to test 3

TEST 3 -

Checking battery voltage on load (Fig.3)Connect a voltmeter across the terminals, as shown in Fig. 3, stop control out: operate the starter switch

Diagnosis:

S.NO	RESULT	ACTION
1	Reading below 9 volts	Remove battery for recharging
2	Reading above 9 volts	Proceed to test 4

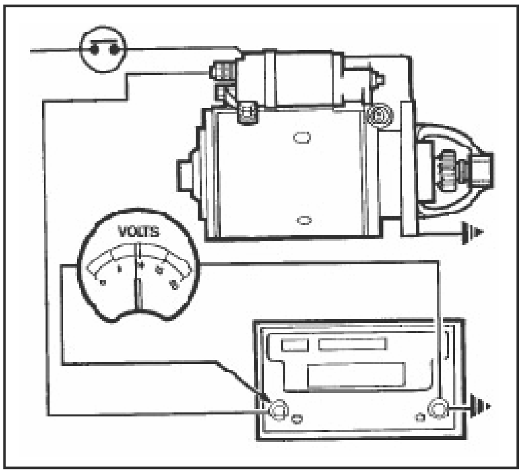

Fig. 3

TEST 4:-

Checking the voltage to the solenoid (Fig. 4)

***If the solenoid operates intermittently during the test or the engine is cranked at low or irregular speed, there may be insufficient voltage at the solenoid operating winding terminal or the solenoid is faulty*.**

To check the circuit for high resistance (poor connections) connect the voltmeter between the solenoid operating terminal and ground (commutator end bracket) as shown in Fig. 4. When the switch contacts are closed, the reading on the voltmeter should be slightly less than the reading in the first part of test 1. A satisfactory reading indicates a negligible voltage drop in the circuit and consequently the fault may be in the solenoid.

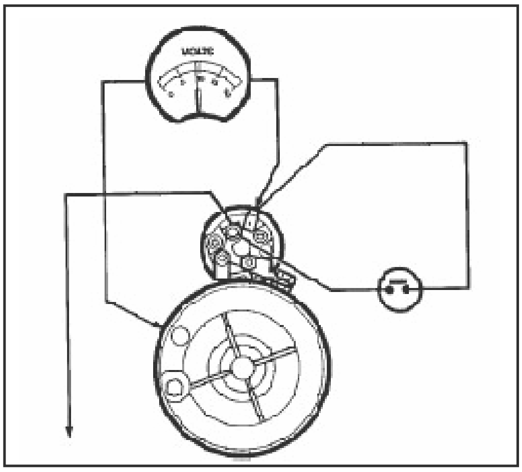

Fig. 4

TEST 5 (Fig. 5) :-

Checking the starter terminal voltage under load conditions (Fig. 5) Connect a voltmeter between the starter input terminal and ground (commutator end bracket) as shown in Fig. 5, stop control out, operate the starter switch.

Diagnosis:

S.NO	RESULT	ACTION
1	Difference in reading taken in test 3 - 0.5 volts	Check all connection
2	Same as in test 3	Proceed to test 5

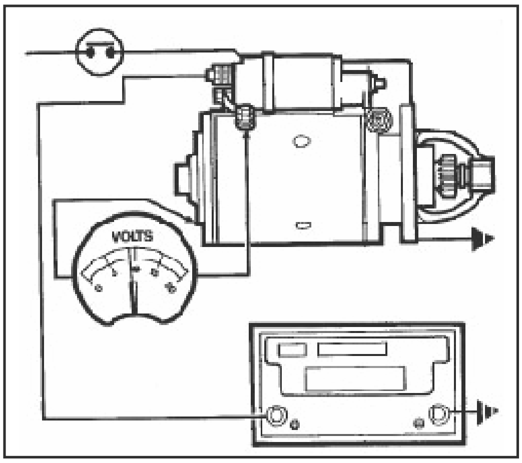

Fig. 5

TEST 6 -

Checking the voltage drop on the insulated line (Fig. 6) Connect a voltmeter between the starter input terminal and the battery positive (+) terminal as shown in Fig.6.

When the starter switch is open the voltmeter should register battery voltage.Stop control out, operate the starter switch.

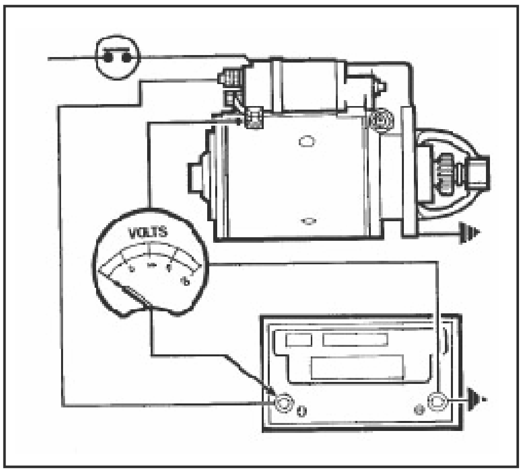

Fig 6

Diagnosis

S.NO	RESULT	ACTION
1	High voltage reading	Rectify faulty or dirty connection
2	Voltage reading partically ZERO	Proceed to test 6

TEST 7 -

Checking the voltage drop across the solenoid contacts (Fig. 7)

Connect a voltmeter between the two main solenoid terminals as shown in Fig.7. When the starter switch is open the voltmeter should register battery voltage. Stop control out, operate the starter switch.

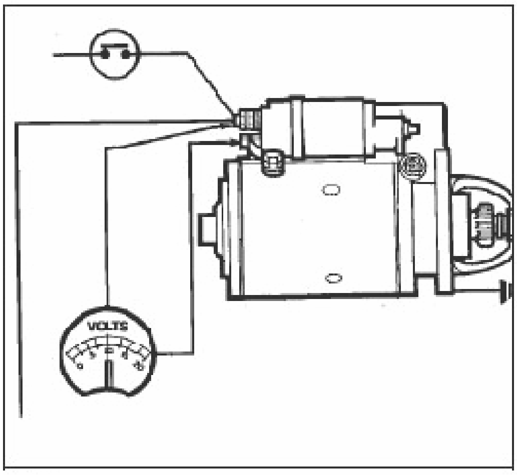

Fig 7

Diagnosis

S.NO	RESULT	ACTION
1	High voltage reading (similar to test 5)	Faulty solenoid - Replace
2	Voltage reading partically ZERO	Solenoid satisfactory

TEST 8:-

Checking the voltage drop on the ground line (Fig. 8)Finally check the voltage drop on the ground line. Connect the voltmeter between the battery ground terminal,as shown in Fig. 8, at the following points:

1. Starter commutator end bracket.
2. Starter body.
3. Engine.
4. Battery connection to ground.With the stop control out, operate the starter switch

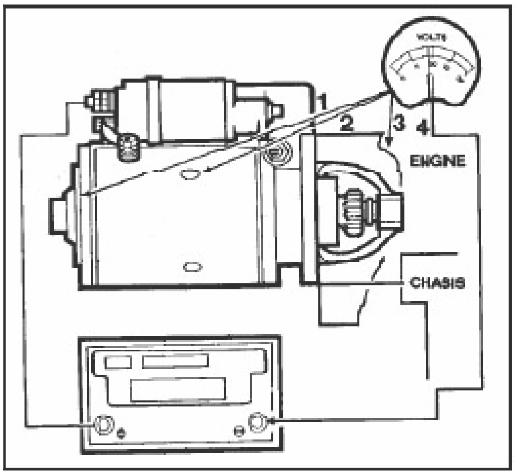

Fig 8

S.NO	RESULT	ACTION
1	Above 0.5 volt	Check all ground connections between starter and battery
2	Voltage reading partically ZERO	Ground lines statisfactory

14B . 5 TRANSMISSION NEUTRAL START SWITCH

Removal and refitment

Removal

1. 2600 tractors - Pull the cable and lift the hood
2. Disconnect the battery, removing the negative cable (-) first in the interest of safety.
3. Disconnect the two wires.
4. Unscrew the switch from the top of the gearbox.

Refitment

5. Reverse procedures 1 to 4.

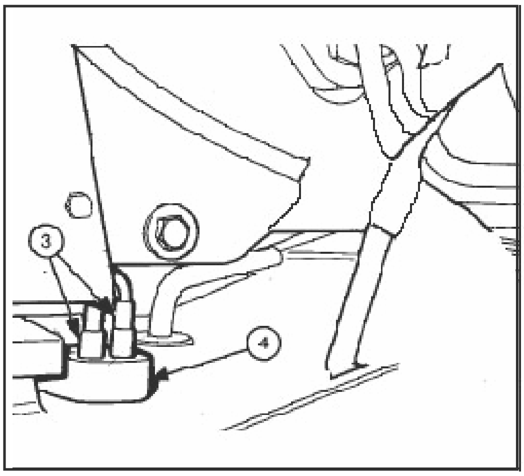

Fig 9

14B . 6 PTO NEUTRAL START SWITCH

Removal and refitment

Removal

1. Disconnect the battery, removing the negative cable (-) first in the interest of safety.
2. Turn back the rubber boot.
3. Disconnect the two wires.
4. Unscrew the retaining nut.
5. Remove the switch.

Refitment

6. Reverse procedures 1 to 5.

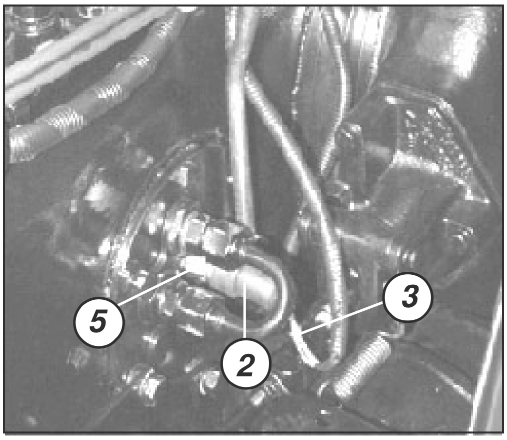

Fig 10

14 B . 7 STARTER MOTOR

Removal and refitment

Removal

1 2600 tractors - Pull the cable and lift the hood

2 Disconnect the battery, removing the negative cable (-) first in the interest of safety.

3 Disconnect the cables from the starter solenoid.

4 Remove the nuts and washers and/or mounting bolts.

5 Withdraw the motor, while supporting it from beneath.

Refitment:

WARNING: All guards and covers over the electrical terminals on the starter MUST be replaced to prevent starting the engine by shorting across the terminals.

7. Reverse procedures 1 to 5 except:

a. Tighten the starter motor terminal to a torque of 62 lbf.inch(7 Nm).

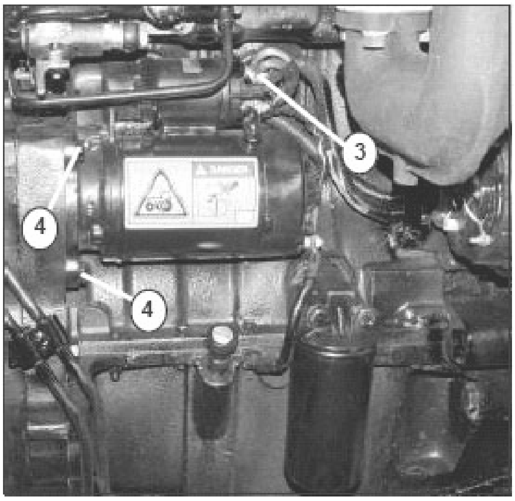

Fig 11

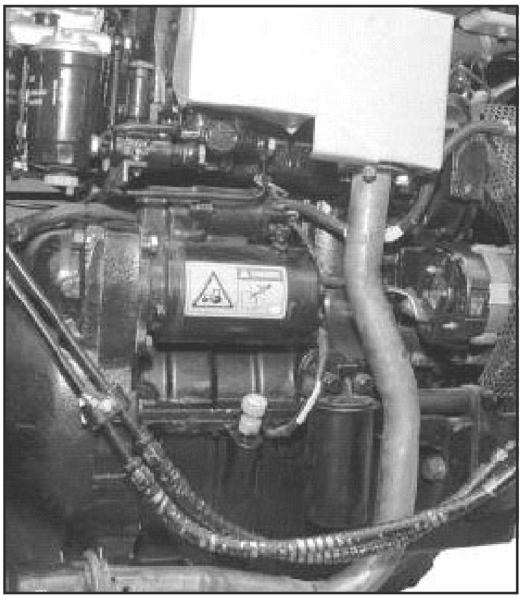

Fig 12

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SECTION 14

PART C

ALTERNATOR

SECTION 14

PART C

ALTERNATOR

TABLE OF CONTENTS

Operation no	Descripition	Page no
14C . 1	Specification	14C - 3
14C . 2	General descripition	14C - 3
14C . 3	Alternator testing	14C - 4
14C . 4	Alternator belt tension	14C - 7
14C . 5	Alternator - Removal and refitment	14C - 8

14C . 1 SPECIFICATION:

Voltage	12 volt negative ground
Alternator - 2600 series tractors	
Make	LUCAS - TVS
Type	A115
Max output	36 Amps
Regulator	Machine sensed
Regulating voltage	14.4 ± 0.2 volts
Location	MF2605 - Left-hand side MF2615 - Right-hand side

Bolt Torques

Alternator pulley nut	29.5 to 34.5 lbs.ft. (40 to 47 Nm)

14C . 2 GENERAL DESCRIPTION:

The alternator is mounted on the right hand side(for MF2615) and left-hand side (For MF2605) of the engine and is driven by a V-belt from the crankshaft pulley. Adjustment of the V-belt tension is provided for with a slotted link and clamp bolts.

ALTERNATOR

Introduction

The alternator produces alternating current which is converted to direct current before being connected to the tractor electrical system. The alternator is provided to supply a source of electrical power used to charge the battery after starting and to operate all the tractors electrical services while the tractor is running.

Routine maintenance

Routine maintenance is limited to wiping away any oil or dirt from around the openings on the alternator and cleaning any dust or chaff that has accumulated internally with a soft brush or air line.

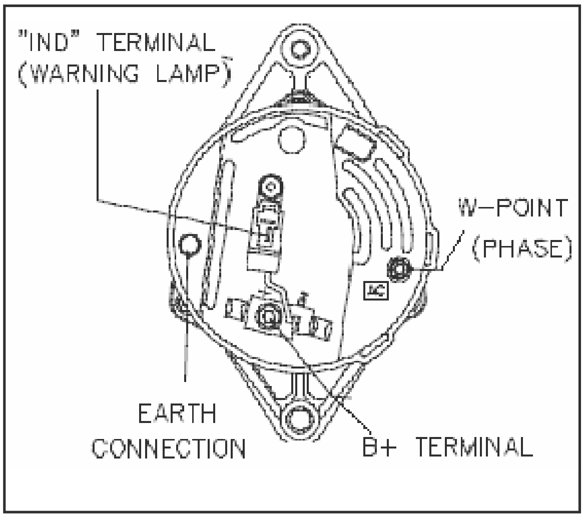


Fig 1

Precautions in service

Various precautions should be taken to avoid damage to the semi-conductor components within the alternator.

1. Do not connect or disconnect any part of the charging circuit, including the battery, while the engine is running.
2. When using a slave battery, or battery charger always observe correct polarity (positive to positive,negative to negative).

14C . 3 Alternator testing (Fig. 1)

The following test will check for normal operation of the alternator by taking voltage and ampere readings at selected points in the circuit. Refer fig 1 on 14 C - 3 .The 'IND' terminal (LUCAS),is the indicator connection from the charging warning light on the instrument panel . Terminal 'B' positive is the connection to the battery and 'W' is the square wave signal to instrument cluster hour counter/RPM meter

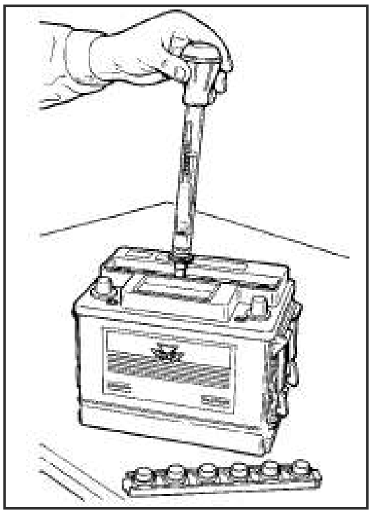


Fig 2

TEST 1 - Battery test (Fig. 2)

Using the hydrometer, check that the battery is at least 70% charged and in good condition.(See fig 2)

Diagnosis:

S.NO	RESULT	ACTION
1	Reading below 1.230	Recharge battery or replace and retest
2	Reading below 1.230 - 1.290	Proceed to test 2&3

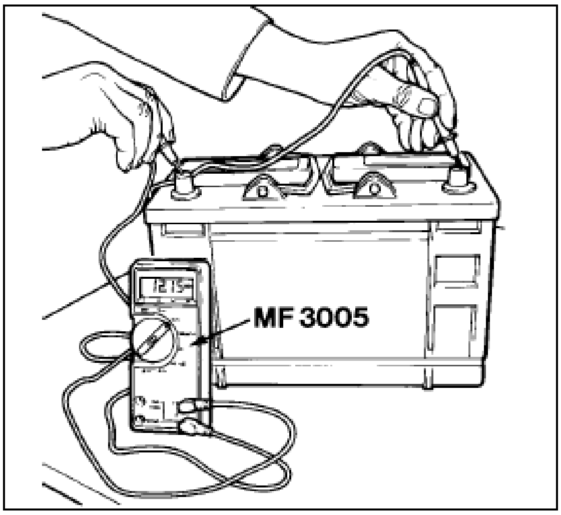


Fig 3

Alternative test (Fig. 3)

Measure the open circuit voltage of the battery with the MF.3005 Digital Multimeter to establish the state of the charge.

Diagnosis:

S.NO	RESULT	ACTION
1	12 volts	Discharged battery - recharge
2	12.4 volts	50% charge - recharge
3	12.7 volts	Fully charged

TEST 2 - Drive belt tension (Fig. 4 & 5)

1. Allow 0.393 inch (10 mm) deflection in MF2615 and 0.314 inch (8mm) in MF2605,when moderate finger pressure is applied to the longest run at the belt, see 'A' Fig. 4 & 5.
2. The alternator will not charge the battery if the belt is too slack. On the other hand, an excessively tight belt may damage the bearings. If the belt is worn or oily, it must be replaced with a new Massey Ferguson belt.

Diagnosis

Result	Action
Belt slack	Adjust
Belt worn	Replace and adjust
Belt statisfactory	Proceed to test 3

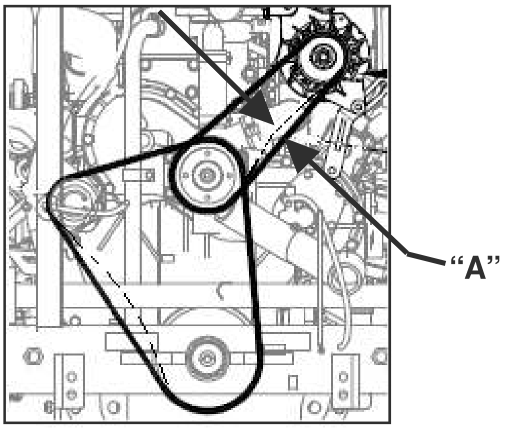


Fig 4 for MF2605

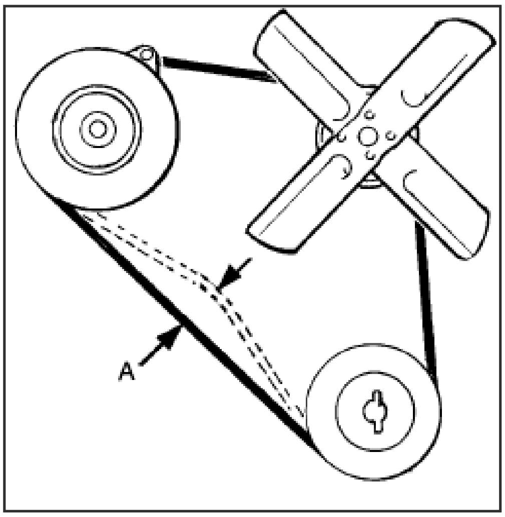


Fig 5 for MF2615

TEST 3 - Wiring connections and continuity (Fig. 6)

1. Ensure that all wires are in position and that connections are clean and tight.
2. Remove the eyelets & lucars from the alternator and connect the negative lead of the voltmeter to the battery ground, then connect the other lead to each terminal in the plug in turn A & B.
3. When testing the lucar terminal (IND test A) the starter switch must be ON (NOT engine cranking). The voltmeter should read battery voltage, if a zero reading is obtained on the lucar terminal (IND) check for faulty bulb in the alternator charging indicator light in the instrument panel.

Diagnosis:

S.NO	RESULT	ACTION
1	Reading below battery voltage	Check all wirings and connections
2	Reading of battery voltage	Proceed to test 4

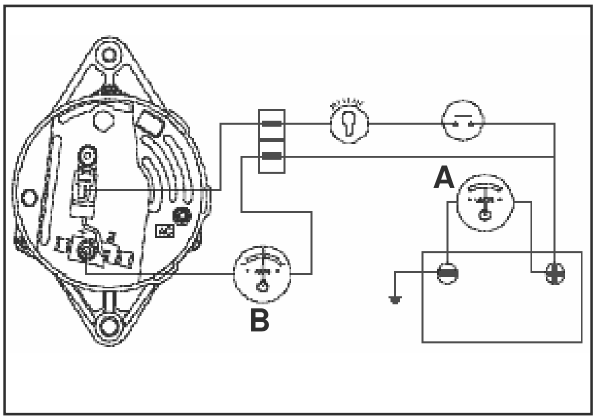


Fig 6

TEST 4 - Checking alternator maximum output (Fig. 7)

The alternator should run for a few minutes to ensure that the tests are carried out at the normal operating temperature. Then stop the engine.

1. Switch on all lights to create a load, and discharge the battery for 1 minute.
2. Disconnect the battery ground cable.
3. Disconnect the wires on the back of the alternator.
4. Connect a test link (jump lead) between the small terminal (IND) on the alternator and the IND connection wire on the harness
5. Connect the ammeter between B positive terminal on alternator and the mating wire on harness

NOTE: *The clips or test probes on the ammeter MUST NOT touch the alternator casing before or during the test. A short circuit will result which will damage the alternator.*

6. Re-connect the battery ground cable.
7. Switch on, check that the warning light comes on.
8. Start the engine and slowly increase to maximum rated speed, the ammeter reading should equal the maximum rated output of the alternator of 30 to 35 Amps.

NOTE: *As the state of charge of the battery increases so the output of the alternator will decrease. The rated output of the alternator should be checked quickly.*

Diagnosis:

Result	Action
Ammeter reading low	Replace or repair alternator
Ammeter reading 40 - 45 Volts	Proceed to test 5

TEST 5 - Checking voltage drop in charging circuit (Fig. 8)

Use a voltmeter to check for high resistance (poor connections) in the charging circuit, see Fig. 8.

1. Connect a voltmeter between the battery insulated (+) terminal and the alternator main output terminal.
2. Switch on all lights to create a load. Start the engine and increase to maximum rated speed. The voltmeter reading should not exceed 0.5 volts.

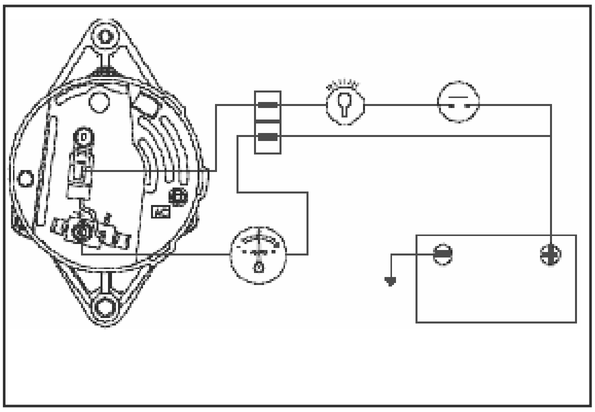


Fig 7

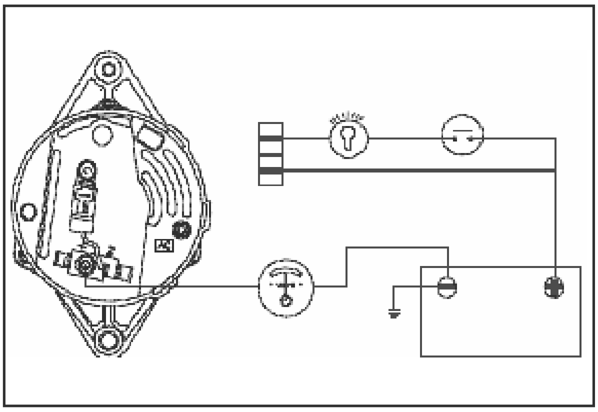


Fig 8

3. Transfer the voltmeter connections to the battery ground (-) terminal and the alternator body.
4. Start and run the engine as in (2).The voltmeter reading should not exceed 0.25 volts.

S.NO	RESULT	ACTION
1	2.Reading above 0.5 volts	Check all wirings for loose connections
2	4.Reading above 0.35 volts	
3	Reading below 0.5 volts	Proceed to test 6

TEST 6 -

Checking voltage regulator setting (Fig. 9) Before checking the voltage regulator setting, it is essential that a battery in a well charged condition is fitted to the tractor.

1. Disconnect the battery ground (-) cable.
2. Connect an ammeter between the starter solenoid terminal and the alternator main output cable.
3. Connect a voltmeter across the battery terminals. See Fig. 9.
4. Reconnect the battery ground cable.
5. Start the engine and increase the speed until the ammeter reading is less than 10 amperes. The voltmeter should be within the limits of 13.6 to 14.4 volts.

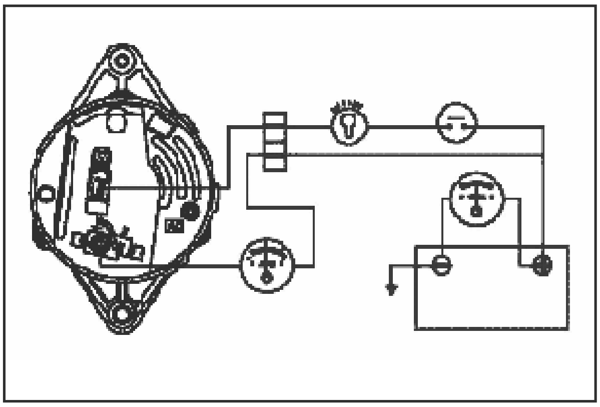


Fig 9

Diagonsis:

S.NO	RESULT	ACTION
1	Reading is unstable or outside specified limits	Voltage regulator faulty - Replace
2	Reading 13.6 - 14.4 volts	Regulator statisfactory

14C . 4 ALTERNATOR BELT TENSION:

Adjust

Procedure

1. Check the belt tension at the centre of the longest span. Allow 0.393 inch (10 mm) deflection in MF2615 and 0.314 inch (8mm) in MF2605,when moderate finger pressure is applied to the longest run at the belt, see ‘A’ Fig. 4 & 5
2. If the belt tension is incorrect, slacken the mounting bolts.
3. Adjust the tension.
4. Re-tighten the bolts and recheck the belt tension.

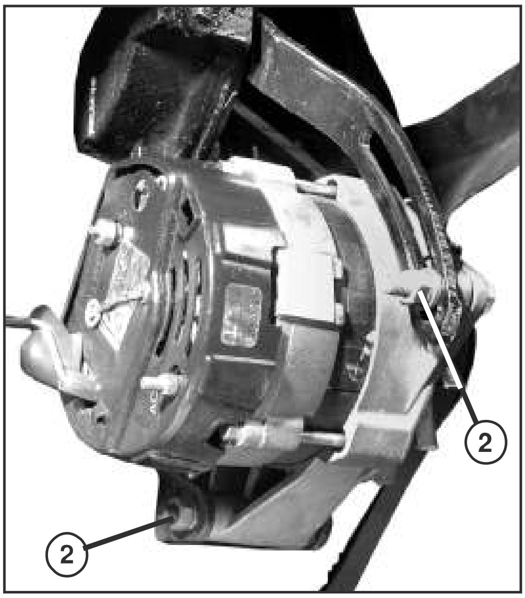


Fig 10

14C . 5 ALTERNATOR

Removal and refitment

Removal

1. 2600 series tractors: Pull the cable and lift the hood
2. Disconnect the battery, removing the negative cable (-) first in the interest of safety.
3. Remove the connections from the alternator terminals.
4. Slacken the pivot bolt.
5. Remove the clamp bolt.
6. Remove the guard, if fitted
7. Remove the fan belt from the alternator pulley.
8. While supporting the alternator, partially remove the pivot bolt.
9. Remove the alternator.
10. Remove the pulley guard and pivot bolt.

Refitment

11. Reverse procedures 1 to 10.
12. Adjust the belt tension, see operation 4 & 5.
13. If the pulley has been removed tighten the nut to a torque of 44 lbf.ft (60 Nm).

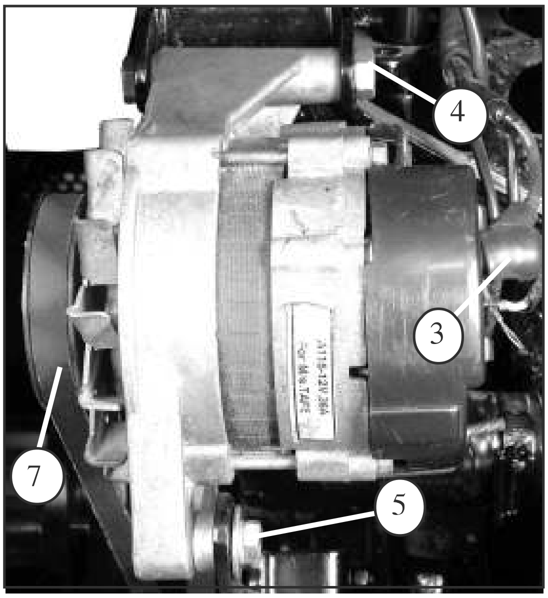


Fig 11

SECTION 15

Wheels and Tires

WHEELS AND TIRES

Table of Contents

Operation No.	Description	Page No.
15.A.1	Specification for MF2605 … … …	15A - 3
15.A.2	Specification for MF2615	15A - 4
15.A.3	Rear Wheels and Tires … … …	15A - 5
15.A.4	Track Settings … … …	15A - 7
15.A.5	Front Wheels and Tires … … …	15A - 8
15.A.6	Inner Tube Removal and Refitment … …	15A - 8
15.A.7	Tire Removal and Refitment … … …	15A - 10
15.A.8	Ballasting … … …	15A - 11
15.A.9	Fault Finding Chart … … …	15A - 13

15.A.1 SPECIFICATION FOR 2605 (2WD):

Front Tires : 6.00 × 16 - 6 PR

Rear Tires : 13.6 x 28 - 8 PR

SPECIFICATION FOR 2605 (4WD):

Front Tires : 10.5/80 x 18

Rear Tires : 13.6 x 28 - 8 PR

Recommended tires pressures

Front Tires: 29 psi/200 Kpa/2.0 Kgf/cm^2 -for field work (For 2WD/4WD)

34psi/230 Kpa/2.3 Kgf/cm^2 -for haulage (For 2WD/4WD)

Rear Tires: 12psi/80 Kpa/0.8 Kgf/cm^2 -for field work

18psi/120 Kpa/1.2 Kgf/cm^2 -for haulage

10psi/70 Kpa/0.7 Kgf/cm^2 -for paddy work

CAUTION : Do not run the tractor with low tire pressure.

Check the tightness of front wheel bolt and rear wheel nuts frequently

Front Wheel bolt - 60 lbf.ft. (81 Nm)
Rear Wheel Nut - 190 - 200 lbf.ft. (258 - 271 Nm)

Torque Values

Disc to rim : 90 – 110 lbf. ft.(122 - 149 Nm)

Rear wheel nuts : 190 – 200 lbf. ft.(258 - 271 Nm)

Front wheel bolts : 60 lbf. ft. (81 Nm).

Special Tool

“Bead-breaking” tool

3 lb Hammer

Tire Levers

15.A.2 SPECIFICATION FOR 2615 (2WD):

Front Tires : 7.50 X 16 - 6 PR

Rear Tires : 13.6 x 28 - 8 PR

SPECIFICATION FOR 2615 (4WD):

Front Tires : 10.5 / 80 x 18

Rear Tires : 13.6 x 28 - 8 PR

Recommended tires pressures

Front Tires: 29 psi/200 Kpa/2.0 Kgf/cm^2 -for field work (For 2WD/4WD)

34psi/230 Kpa/2.3 Kgf/cm^2 -for haulage (For 2WD/4WD)

Rear Tires: 12psi/80 Kpa/0.8 Kgf/cm^2 -for field work

18psi/120 Kpa/1.2 Kgf/cm^2 -for haulage

10psi/70 Kpa/0.7 Kgf/cm^2 -for paddy work

CAUTION : Do not run the tractor with low tire pressure

Check the tightness of front wheel bolt and rear wheel nuts frequently

Front Wheel bolt - 60 lbf.ft. (81 Nm)
Rear Wheel Nut - 190 - 200 lbf.ft. (258 - 271 Nm)

Torque Values

Disc to rim : 90 – 110 lbf. ft.(122 - 149 Nm)

Rear wheel nuts : 190 – 200 lbf. ft.(258 - 271 Nm)

Front wheel bolts : 60 lbf. ft. (81 Nm).

Special Tool

"Bead-breaking" tool

3 lb Hammer

Tire Levers

15.A.3 REAR WHEELS AND TIRES

Rear Tires

General

The tires fitted to the tractors can be divided fairly easily into three separate categories :

1. Field.
2. Universal Field and Road.
3. Grassland, Sand or Hard Surface.

Each of the above types of tire has been designed especially to give the best grip and wear characteristics obtainable in the specified conditions. On grassland, such as parks and golf courses, worn field or universal type tires can also be used successfully.

Traction

Very few tractors are used to their fullest capacity, mainly due to inability of the driver to control excessive wheelspin.

If a tractor is being driven along a smooth, flat surface, the tire tread will grip the road provided that the torque applied to the wheel is not in excess of the coefficient of friction between the tire and the road. When the tire grips the road without slipping, the condition is one of 100% traction.

Unfortunately, due to tread design and other factors, the maximum rate of traction normally obtainable in the most favourable conditions (i.e. smooth concrete) is approximately 90%, i.e. the tractor will pull a load of 90% of the weight acting on its rear wheels, e.g. a tractor is working on smooth dry concrete, with a weight of 5000 lb. acting on its rear wheels. Allowing for a coefficient of traction of 90%, the tractor will be capable of pulling a load of approximately.

When ploughing, or performing smiler operations in the field, the coefficient of traction is reduced to around 45 to 50%. This is the reason for ballasting the rear end of the tractor, thereby increasing the weight acting on the rear axle and thus increasing the tractive effort of the tractor.

$$\frac{5000}{1} \times \frac{90}{100} = 4500 \text{ lb}$$

The coefficients of traction mentioned above can only be achieved by ensuring that all of the factors which affect tractor performance are adjusted to suit the ground conditions.

Some of the factors are :

1. Tire Pressures – must be set at the lowest pressure permissible for the load being carried and the size and ply-rating of tire being used.
2. Tire Tread – the tire tread should not be more than 1/3 to 1/2 worn for efficient ploughing. The lug-bars must face in the correct direction (most tires have arrows on the sidewalls to indicate the correct direction of rotation).
3. The correct section and size of tire should be used for certain ground conditions. Some examples are:
   (a) Clay – Large diameter, narrow section tires. These tires have a small contact area and will concentrate a larger amount of weight on the contact area than would a wide section tire, thus helping the lug-bars to ‘bite’ into the soil and give traction.
   (b) Very light sandy soil – or peat. Any wide section tire will allow the weight acting on the rear end of the tractor to be spread over a larger area than with a narrow tire, thus preventing sinkage and crushing of the furrow.
   (c) Stony Ground – Large diameter, wide section tires will spread the wear out over a large area of tread and give good flotation.
   (d) Sand – Sand requires an entirely different type of tire, for if ordinary lug-bar type tires are used they will greatly disturb the surface of the sand and rapidly dig themselves into an every increasing depth. In these conditions, a smooth tread pattern, on as wide a tire as possible is required, to disturb the surface as little as possible and give good flotation.

Pressures

Tire pressure must be maintained at the manufacturer's recommended minimum to give the best possible performance.

Incorrect inflation of tires has the following effects:

Over-inflation

Excessive tire pressure deprives the tire of its self-cleaning properties. This causes wheelspin, which in turn causes sinkage, thus increasing the rolling resistance of the tire and lowering the power available for traction.

Frequent and prolonged bouts of wheelspin cause rapid tire wear. Another effect of over-inflation is that the tread and sidewalls of the tire are very susceptible to damage from sharp rocks or similar objects due to the inability of the casing to 'give' on contact.

Under-inflation

If a tire has insufficient pressure to support the casing, this may be deflected to such an extent that the plies may become separated. Such damage is irrepairable and the tire must be replaced. Excessive deflection allied to a high drawbar pull can cause wrinkling of the tire sidewalls which, if allowed to occur continually can cause the tire to 'creep' on the rim and tear out the valve.

A visible warning of under-inflation is uneven wear of the lug-bars, indicated by 'gouging' of the centre of the bars.

Cleanliness

Certain liquids can cause considerable harm to tires, if they are not quickly removed. Some of the worst offenders are oil, grease and some crop sprays, which can contain considerable quantities of acid or alkali. If any of the above penetrate into the plies through small holes or splits, rapid deterioration will result.

Effective Tires Pressures

Under normal conditions the following pressures can be used, but must be increased if extra loading is involved.

Ploughing : 12 psi (0.844 kg. / cm.^{2})

If bolt-on ballast weights are used, the pressure must be raised accordingly. When working on a hillside pressure should be raised by 2 psi (0,14 kg / cm.^{2}) in both tires, because as each tire alternately takes most of the load when it is on the side of the tractor nearest the bottom of the slope, the pressure must be raised accordingly to slope.

When using a non-reversible plough the pressure of the land side tire may be reduced by 2 psi (0,14 kg. / cm.^{2}), although the differential lock if fitted should be used to compensate for wheelspin by one wheel only.

Road Work

When driving a tractor on the road, higher speeds can be used then in the field. In such conditions the pressure can be raised by 4 psi (0,28 kg./ cm.^{2}) to prevent squirming and gouging of the lug-bars.

If a two-wheel trailer, or manure spreader is used, the weight exerted on the tractor drawbar should be determined and, the pressure adjusted to suit.

Using a Front End Loader

If a loader is fitted to the tractor, a counter-weight is frequently fitted to the tractor rear linkage as a safety precaution. If a counter-weight is to be fitted, the tire pressure should be raised to compensate.

15.A.4 TRACK SETTINGS FOR MF 2605

Front Wheel Track settings can be varied from 52.8 to 72.8 inch (1320 to 1830 mm) in 4 inch (102 mm) increments. Track

Rear Wheel Track settings can be varied from 52.8 to 72.8 inch (1341 to 1849 mm) in 4 inch (102 mm) increments. Track

FRONT TRACK FOR 2WD

The front wheel track is adjustable in steps of 4 inch (102 mm approx.) from 52.8 to 72.8 inch (1320–1830 mm). The settings are obtained as follows: (Refer Fig. 1a).

Jack up the tractor and remove three bolts securing each front axle to centre axle and spread axle arms to obtain desired track width. No change in steering connections is necessary. Replace bolts, leaving at least one bolt hole between the two bolts to give additional support.

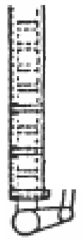
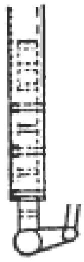
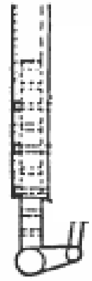
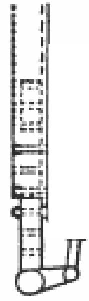
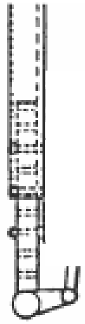
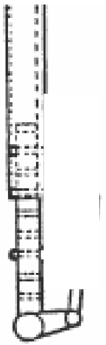
1341 mm (52.8 inch)	1443 mm (56.8 inch)	1544 mm (60.8 inch)	1646 mm (64.8 inch)	1748 mm (68.8 inch)	1849 mm (72.8 inch)
					

Fig. 1a

REAR TRACK

The rear wheel track is adjustable in 4 inch (102 mm, approx.) steps from 52 to 72 inch (1320 mm to 1828 mm) The settings are obtained as follows: (Refer Fig. 1b).

The rear wheel track is adjustable by assembling the disc and rim in different positions. At the same time, interchanging of the wheels may be necessary in order to maintain maximum traction.

Ensure that the rear tires are on their correct side by checking that the arrow on the side of the tire points in the direction of forward rotation.

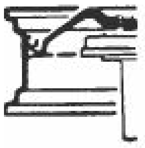
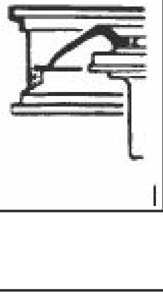
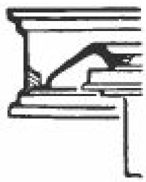
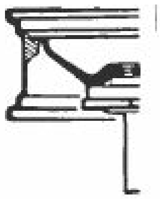
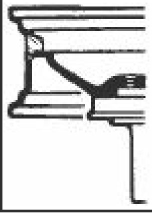
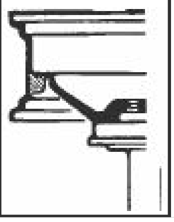
52 inch 1320 mm	56 inch 1422 mm	60 inch 1524 mm	64 inch 1625 mm	68 inch 1727 mm	72 inch 1820 mm
					

Fig.1b

15.A.4 TRACK SETTINGS FOR MF 2615

Front Wheel Track settings can be varied from 53.6 to 73.6 inch (1320 to 1830 mm) in 4 inch (102 mm) increments. Track

Rear Wheel Track settings can be varied from 52 to 72 inch (1445 to 1897 mm) in 4 inch (102 mm) increments. Track

FRONT TRACK FOR 2WD

The front wheel track is adjustable in steps of 4 inch (102 mm approx.) from 52.8 to 72.8 inch (1361 - 1870 mm). The settings are obtained as follows: (Refer Fig. 1a.1).

Jack up the tractor and remove three bolts securing each front axle to centre axle and spread axle arms to obtain desired track width. No change in steering connections is necessary. Replace bolts, leaving at least one bolt hole between the two bolts to give additional support.

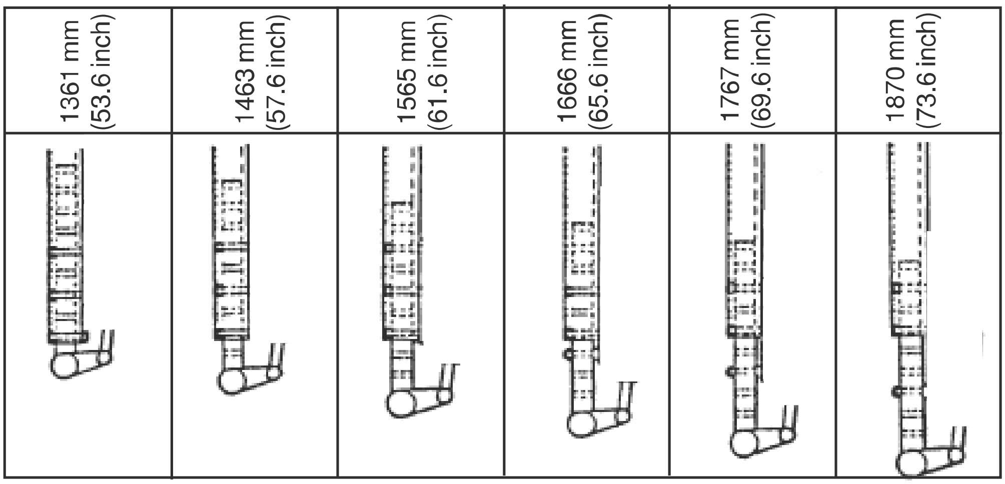

1361 mm (53.6 inch)
1463 mm (57.6 inch)
1565 mm (61.6 inch)
1666 mm (65.6 inch)
1767 mm (69.6 inch)
1870 mm (73.6 inch)

Fig.1a.1

REAR TRACK

The rear wheel track is adjustable in 4 inch (102 mm, approx.) steps from 52 to 72 inch (1320 mm to 1828 mm) The settings are obtained as follows: (Refer Fig. 1b.1).

The rear wheel track is adjustable by assembling the disc and rim in different positions. At the same time, interchanging of the wheels may be necessary in order to maintain maximum traction.

Ensure that the rear tires are on their correct side by checking that the arrow on the side of the tire points in the direction of forward rotation.

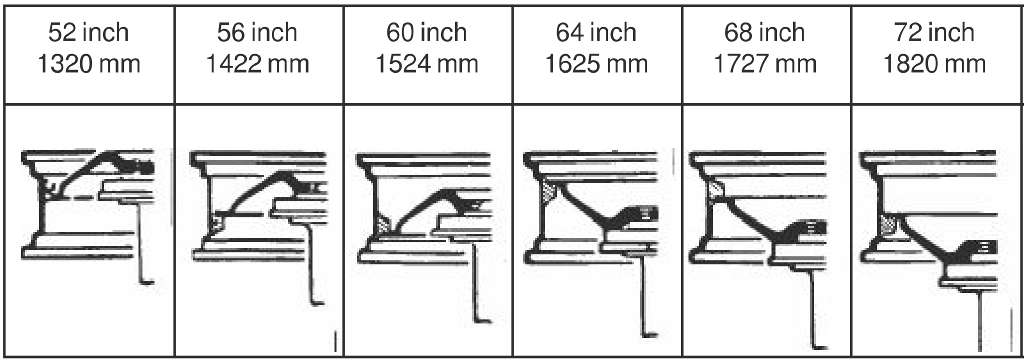

52 inch 1320 mm
56 inch 1422 mm
60 inch 1524 mm
64 inch 1625 mm
68 inch 1727 mm
72 inch 1820 mm

Fig.1b.1

15.A.5 FRONT WHEELS AND TIRES

The Tractor fitted with pressed steel rims and discs.

Tire Pressures

Front tire pressures are very critical, as they can affect the steering characteristics of the tractor considerably.

Refer specifications section for recommended tire pressure.

Front Wheels and Tires

For removal and refitment of front tube and tire, follow the procedure given for rear tire and ensure the front wheel pressure is maintained as per recommendation.

Note : *Always use a safety cage (Fig. 2.)*

15.A.6 REAR INNER TUBE

Removal and Refitment

Special Tools

"Bead-breaking" tool

3 lb Hammer

Tire Levers

Removal

1. Lay the wheel on the ground with the valve stem up.
2. Deflate the tire by removing the valve core and the valve retaining nut.
3. Drive the "Bead-breaking" tool between the tire and rim, taking care not to damage the rim or the tire. (Fig. 3).
4. After the bead has been released from the rim, invert the wheel and repeat above procedure 3.
5. Lubricate the rim, tire and base of the tube with a solution of soap and water or similar rubber lubricant. (Fig. 4).

Note : *Never use petroleum or silicone base greases.*

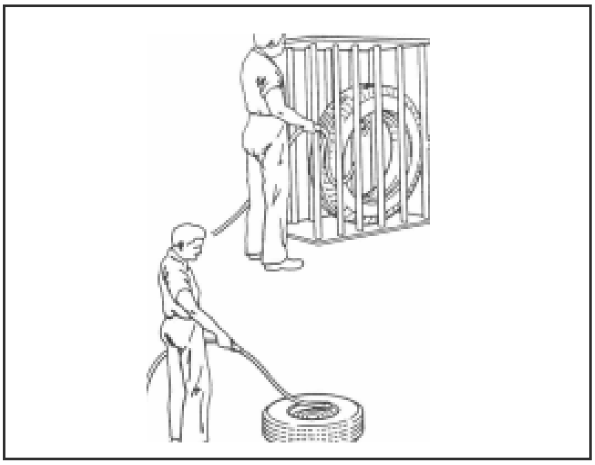


Fig. 2

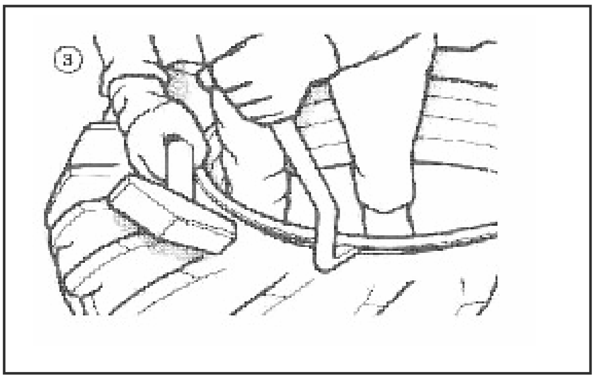


Fig. 3

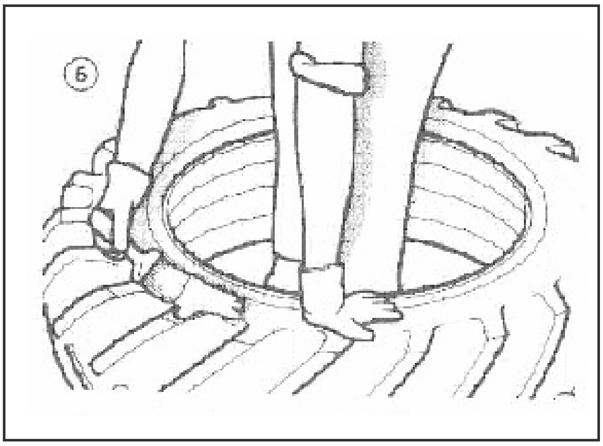


Fig .4

6. Starting at the valve location, pry the tire off the rim, taking small bites with tire levers, and ensuring that the bead on the opposite side is fully located in the mounting well. (Fig. 5).
7. With the wheel in a vertical position, pull the tire forwards and remove the tube. (Fig. 6).

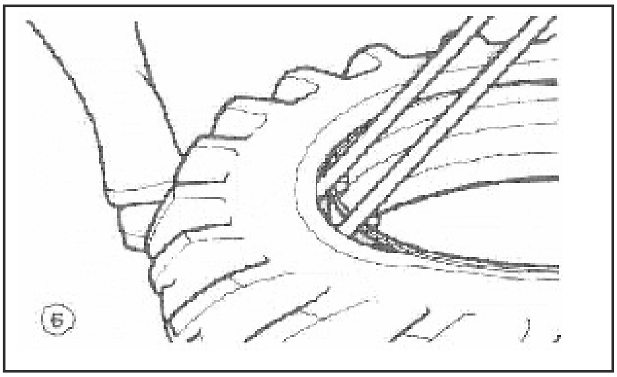


Fig. 5

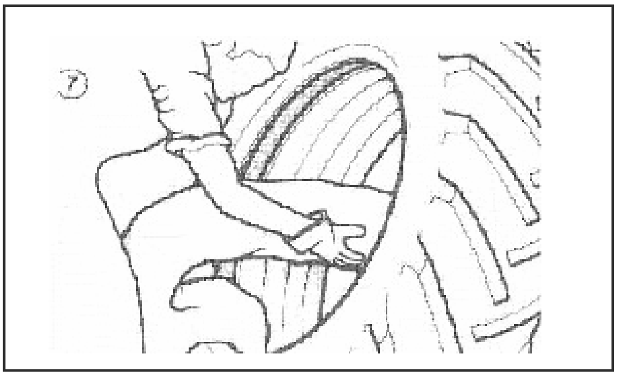


Fig. 6

Examinations

Examine the bead seating area of the rim. Remove any build-up of rust, corrosion or old rubber. Inspect inside the tire casing for foreign matter or damage.

Refitment

1. Inflate the tube until “rounded out”. Place the tube in the tire with the valve located in the valve hole of the rim. Refit the valve retaining nut to finger tight. (Fig. 7).
2. Refit the tire, starting opposite the valve location taking small bites with long tire levers and keeping the fixed part of the bead fully located in the well. (Fig. 8).

   A solution of soap and water, or similar rubber lubricant, brushed onto the rim and bead will help fitment.

   Note : *Care must be taken not to pinch the tube when fitting.*

3. Centre the tire on the rim and inflate to approx. 2.5 kg/cm^2 (35 psi).

   WARNING : Never stand over the assembly when inflating, remote control inflation equipment should be used.

4. Remove the valve core and completely deflate the tire.
5. Refit the valve core and inflate to recommended pressure.

   Note : *If beads fail to seat at 2.5 kg/cm^2 (35 psi) the tube may be pinched, do not increased the pressure but remove the valve core and release tire from rim. Lubricate tire, bead and rim and re-inflate to 2.5 kg/cm^2 (35 psi) repeat process unit both beads are properly seated.*

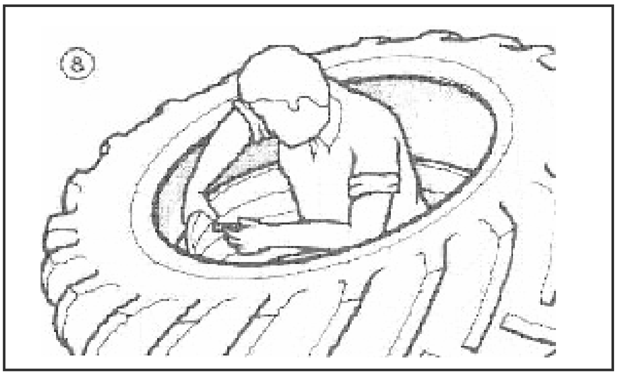


Fig. 7

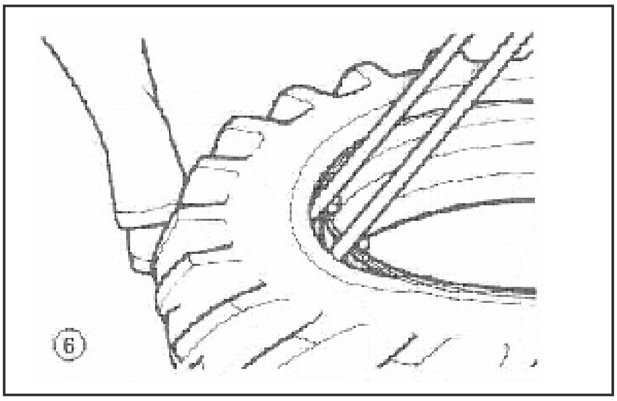


Fig. 8

15.A.7 REAR TIRE

Removal and Refitment

Special Tools

"Bead-breaking" tool

3 lb Hammer

Tire Levers

Removal

1. Remove the inner tube. See operation 15.A.6.
2. With the wheel in a vertical position pry off the tire taking small bites with the tire levers. The use of rubber lubricant will help removal. (Fig. 9).

Refitment

1. Place the rim on the ground, lubricate the bead and rim and place the tire on rim. (Fig. 10).
2. Refit the tire to rim, using long tire levers. (Fig. 11).
3. Refit the inner tube.

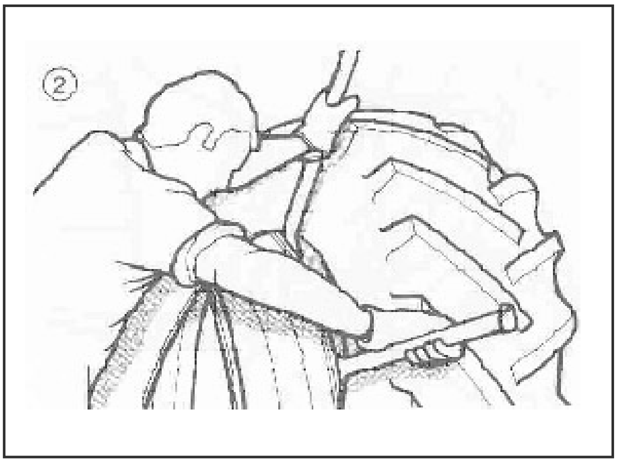


Fig.9

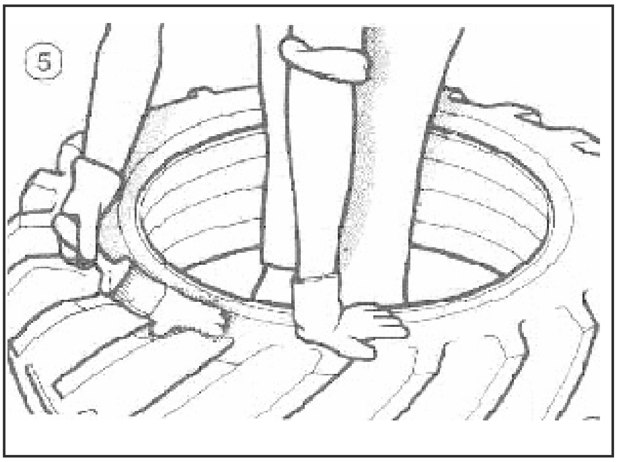


Fig.10

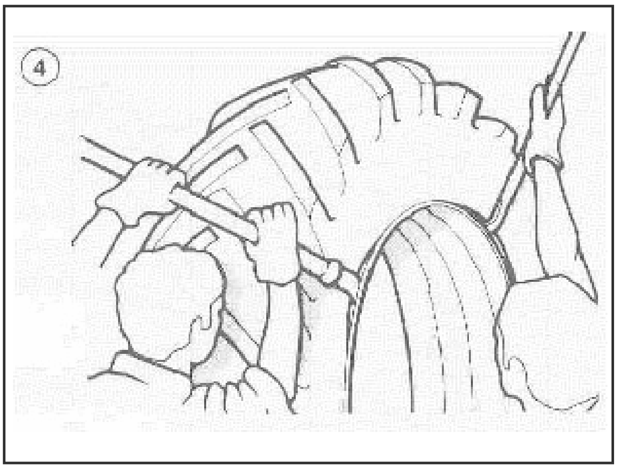


Fig.11

15.A.8 BALLASTING

Liquid Ballast

Liquid filling of tires is a well known and widely used method of weighting the rear of a tractor. To prevent tire damage by frost, calcium chloride should be dissolved in the water used to fill the tires, thus forming an anti-freeze solution. The calcium chloride used should be “Commercial Grade 70 to 72% Ca.Cl$_2$.”.

Ballasting Procedure

WARNING : Never pour water on to calcium chloride, always add calcium chloride to water.

Never attempt to add pure calcium chloride to a tire filled with water, as the resultant heat and expansion can cause tire damage.

There are two separate methods of liquid ballasting tractor tires :

1. 75% filling.
2. 100% filling.

The 75% filling method is the most common, being somewhat easier to achieve than 100% filling and not requiring a motorised pump.

75% Ballasting

1. Using the tractor jack, raise the rear wheels just clear of the ground.
2. Ensure that the tire valve is secured to the rim, either by a mounting cone or valve nut. If so, deflate the tire.
3. Check that an air-water type valve core is fitted to the valve.
4. Position the valve by turning the wheel until the valve is at “12 O’clock”. (i.e. vertical and at the top).
5. Connect the water adapter to the valve and place the solution suction tube in the tank of solution.
6. Pump the solution into the tire until a steady stream of solution pours from the breather hole. This indicates that the tire has been filled up to the level of the valve, which is approximately 75% of the tire’s capacity.
7. Disconnect the water adapter.
8. Using a special air-water gauge, adjust the air pressure in the tire to that recommended for the load being carried by the rear of the tractor.

100% Ballasting

Note : *A motorised pump is essential for 100% ballasting. Operating procedure is usually provided with such pumps.*

1. Using a floor jack capable of proper lifting capacity, raise the rear wheels clear of the ground.
2. Ensure that the tire valve is secured to the rim, either by a mounting cone or valve nut. If so, deflate the tire.
3. Ensure that an air-water type valve is fitted to the valve body.
4. Position the valve, by turning the wheel, until the valve is in the “6 O’clock” position. (i.e. vertical and at the bottom). This is most important.
5. Fit an adapter extension tube to the special type water adapter (Fig. 12). The length of the extension tube depends on the size of tire being filled :

   6 inch (152. 4 mm) tube for 7 to 10 inch (177.8 to 254 mm) tires.

   8 inch (203. 2 mm) tube for 10 to 13 inch (254 to 330.2 mm) tires.

   12 inch (304. 8 mm) tube for 13 to 15 inch (330.2 to 381 mm) tires.
6. Fit the adapter and extension tube to the valve.
7. Pump solution into the tire until it pours from the breather hole.
8. Turn the wheel until the valve is in the "12 O’clock" position.
9. Continue pumping until the solution again pours from the breather hole. When this occurs, the tire should be 90 to 97% full.
10. Remove the adapter and extension tube.

    When the tire is in this condition, the small space at the top of the tire containing air cannot be filled satisfactorily. In fact, this small space will be at only 6 – 7 psi (0,455 kg. / cm^2) and will act as a ‘cushion chamber’. This lower pressure will also allow the tire to ‘bulge’ slightly more, but the water will give the sidewall plies more support than would the same pressure of air, thus allowing the tire to retain its self cleaning properties and strength.

Essential Facts when Liquid Ballasing

1. Always use a proper air-water pressure gauge, as a normal air type gauge will be rapidly corroded by calcium chloride solution.
2. Never attempt to inflate the tire with the wheel resting on the ground.
3. Always use an open topped container when mixing calcium chloride solution.
4. Never pour water on calcium chloride.
5. Always partially inflate the tire with the valve in the lower position when 100% ballasting.

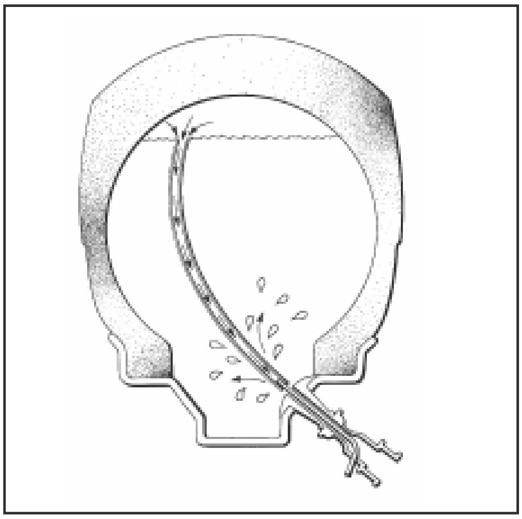


Fig. 12

15.A.9FAULT FINDING CHART

Symptom	Possible Cause	Suggested Cure
Wheelspin	Too low gear	Use the highest gear that the tractor will pull without labouring
Wheelspin due to tires loading with soil	Tire pressures excessive	Adjust the pressures to the manufacturer's recommended minimum
	Inadequate tire pressures	Raise the tire pressure to that correct for the load on the rear end of the tractor
	Insufficient weight acting on the rear end of the tractor	1. Fit wheel weights 2. Water ballast tires. 3. Try narrower section tires.
Wheelspin the tire retains its self-cleaning action and sinks into the ground	Inadequate weight on the front end of tractor	Fit weight frame and front-end weights
	Too narrow section tire for the weight being carried by the rear end of the tractor	1. Fit wider section tires. 2. Reduce the weight on the rear end of the tractor
	Lug-bar type tires being used in sand	Use either grassland / sand type tires, or heavily worn lug-bar type tires
Tractor swerves from side to side when being driven on hard ground (e.g. road)	Tire squirms due to excessively low pressures	Raise the tire pressures.This compliant can cause rapid tire wall wear and consequential failure
Tire tread worn unevenly when used for long periods on the road	1. Too low pressure 2. Overloading	Raise pressure – This compliant is indicated by wear on the leading and trailing edges of the lug-bar
Uneven tread wear	Over-inflation	Adjust pressure to those recommended by tire manufacturers. This problem is indicated by wear to the centre of the tread only.
	Wheels running out of true	1. Jack up axle to relieve wheel of weight, slacken and retighten wheel nuts. 2. Check that the tire is located accurately on the rim.
Tire creep	Too low tire pressure	1. Increase tire pressure. 2. Check the condition of both the rim and bead and replace as necessary. Certain sizes of wheel are available with knurled rims.
Split side wall	Under-inflated tire striking a sharp object	Minor splits are repairable. In cases of severe damage the tire must be replaced.

SECTION 16

Drawbar and Linkages

DRAWBAR AND LINKAGE

Table of Contents

Operation No.	Description	Page No.
16A.1	Specification … … …	16A.3
16A.2	General Description … … …	16A.5
16A.3	Rod Lift … … …	16A.6
16A.4	Turn buckle … … …	16A.6
16A.5	Swinging draw bar … … …	16A.7
16A.6	Swinging draw bar Adjustment … … …	16A.8

16A.1 SPECIFICATION

Linkage types : Interchangeable ball ends category 1 and 2

Lift capacity at link ends with links horizontal : 3196.70 lb (1450 kg)

Normal-duty drawbar :

Swinging drawbar static load :

- Outer position : 1708.50 lb (775 kg)
- Inner position : 2204.62 lb (1000 kg)

Swinging drawbar distance to PTO shaft :

- Outer position : 14 inch (356 mm)
- Inner position : 10 inch (254 mm)

Bolt Torques

Drawbar frame to center housing : 420 Nm (310 lbf.ft.)

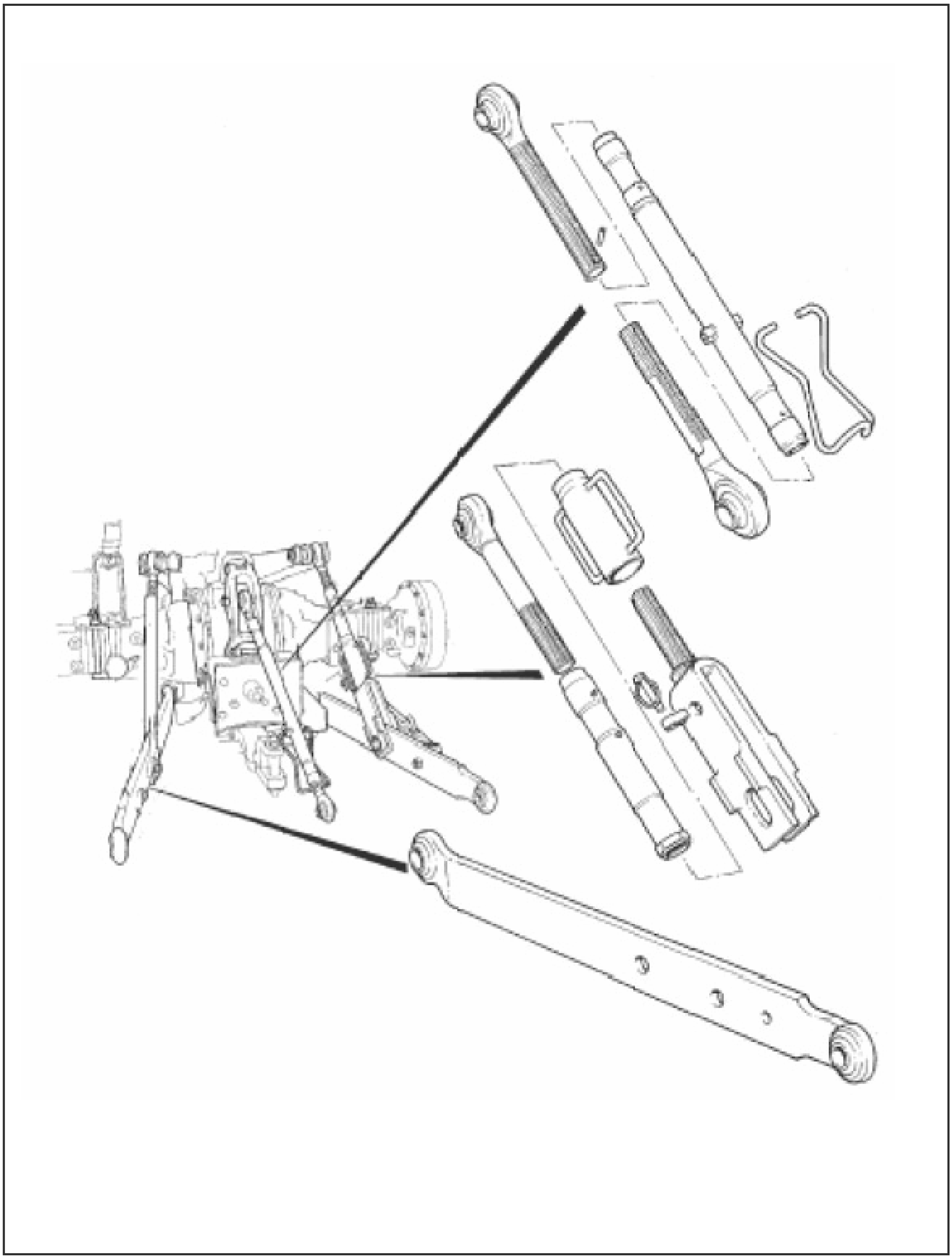


Fig 1

16A.2 GENERAL DESCRIPTION

The three point linkage controls the vertical movements of the mounted and semi-mounted implements.

The Linkage consists of

1. Top link
2. Two lift rods
3. Two lower links
4. Two check chains
5. Interchangeable ball ends
6. Turn buckle
7. Stabilizer chains

Top link

The top link transmits the draft reaction forces from the soil engaging implements to the control spring and plunger assembly in the lift cover.

The top link consists of three main components:

1. Top ball end
2. Turn buckle barrel and spring locking clip.
3. Bottom ball end (Implement end).

The top link is adjustable for length, and the turn buckle is prevented from rotating by the spring locking clip at its top end.

Lift rods

The two lift rods connect the lift arms to the lower links having a knuckle type joint at the top end with the link arms and a swivelling bolt at the bottom end with the lower links.

The left-hand lift rod consists of two main components, knuckle joint and rod lift.

The right-hand lift rod yoke section incorporates a bevel gear levelling box, thus the length can be adjusted for attachment to the implement. By rotating the handle of the levelling box, the yoke shank is screwed out of or into the lower fork.

Lower links

The two lower links can be fitted with various types of ends as follows :

Interchangeable ball category 1 or 2.

Two holes are provided for in the lower link so that the height of lift can be varied.

A spring clip is fitted to the outer end of the lower link toward the implement for storage of the lynch pin when not in use.

Check chains

The two check chains restrict the sideways movement of the lower links to prevent or the implement fouling the inside walls of the rear tires.

The check chains are fitted between the anchor check chain bracket and the inner face of each lower link using the lift rod bolts.

Interchangeable ball ends

Interchangeable ball ends are fitted to the rear ends of the two lower links, thus category 1 and 2 implements can be used.

The ball ends are changed by pulling up a spring wire clip, laying the ball ends flat and aligning the cut out of the ball end with the slot in the lower link and sliding it out. The replacement ball is fitted by reversing the removal procedure.

Turn buckle

The turn buckles is used to adjust the length of the right-hand lift rod, to assist in hitching the implement and to adjust the implement for level.

Stabilizer chains

The two stabilizer chains are adjustable for length using the turn buckels. They must be adjusted to give implement side-swing when fully raised in the transport position.

16A. 3 ROD LIFT

Removal and Refitment

Removal

1. Place the position control lever in the lowered position.
2. Unscrew the two locking nuts. (Item 1 in Fig. 2).
3. Remove the lift rod link arm bolt. (Item 2 in Fig. 2).
4. Remove the split pin. (Item 4 in Fig. 2).
5. Remove the lift rod to lift arm pin. (Item 3 in Fig. 2).
6. Lift the lift rod from its mounted position.

Refitment

For refitment follow the reverse procedure given above and

1. Renew the split pins.

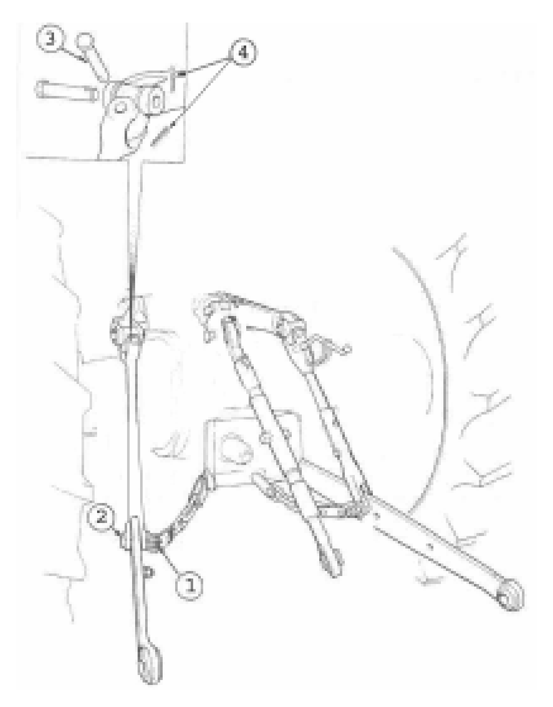


Fig. 2

16A. 4 Turn buckle

Removal and Refitment

Removal

1. Place the position control lever in the lowered position.
2. Unscrew the two locking nuts. (Item 1 in Fig. 3).
3. Remove the Split pin and discard. (Item 2 in Fig. 3).
4. Remove the celvis pin.
5. Remove the Turn buckle. (Item 3 in Fig. 3).

Refitment

For refitment follow the reverse procedure given above and

1. Renew the split pins.

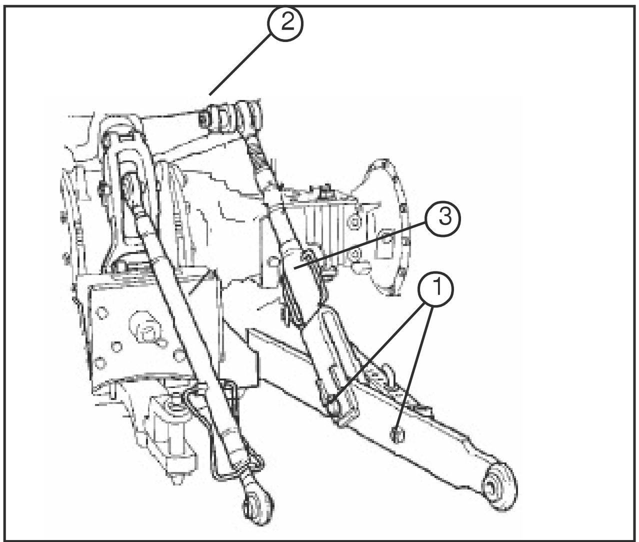


Fig. 3

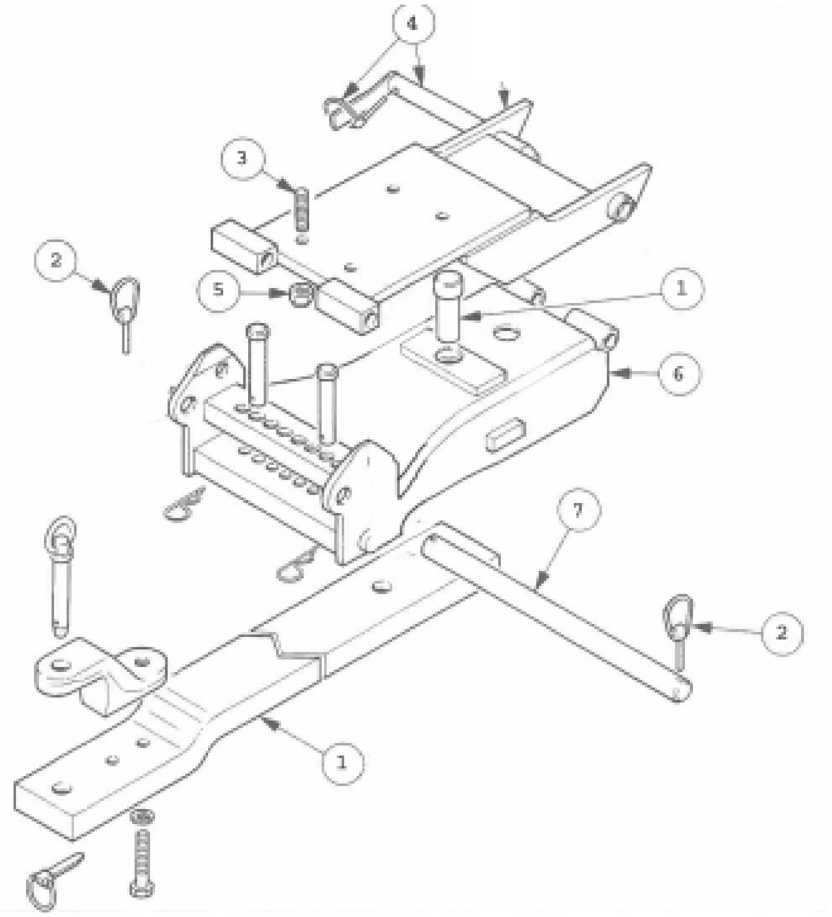


Fig. 4

16A.5 SWINGING DRAWBAR

Removal and Refitment

Removal

1. Support the drawbar, with a suitable adjustable jack.
2. Remove the lynch pin (Item 2 in Fig. 4) and withdraw the pin (Item 7 in Fig. 4).
3. Lower the drawbar and carrier.
4. Remove the retaining pin, (Item 7 in Fig. 4) support the drawbar carrier and withdraw the drawbar from the carrier.
5. While supporting the drawbar carrier remove the lynchpin and withdraw the handled rear pin (Item 4 in Fig. 4).
6. Take out drawbar carrier from the jack.
7. Release the locking washer tabs.
8. Remove the four locking nuts (Item 5 in Fig. 4) retaining the base plate to the center housing and lower base plate from its mounted position.
9. Remove the four studs from the center housing. If necessary. (Item 3 in Fig. 4).
10. Check all parts for wear or damaged and replace, if worn or damaged, with new parts.

Refitment

For refitment follow the reverse procedure given above and

1. If any studs are being replaced refit using loctite 270.
2. Use new carrier plate retaining locking nuts and tighten to a torque of 310 lbf.ft. (420 Nm).

16A.6SWINGING DRAW BAR :

Swinging Draw Bar is used for pulling trailed equipments.The Swinging Draw bar consists of a clevis bar (1in Fig. 5) with a bolted on clevis adopter (2 in Fig. 5) attached to the mounting frame (3 in Fig. 5) by a anchor pin (2 in Fig. 6) and located radially by two headed pins (4 in Fig. 5) which can be fitted in various holes to allow offsetting of bar. A mounting plate is (4 in Fig. 6) is bolted to the base of the center housing by four studs and nuts and the mounting frame gets fixed onto the mounting plate by two securing pins (5 in Fig. 5 and 3 in Fig. 6) which are retained by lynch pins (6 in Fig. 5 and 1 in Fig. 6).

ADJUSTMENTS:

1. ***LENGTH :*** The clevis bar has two holes at the front end for getting two different length adjustments as shown in Fig 7.

   Remove the lynch pin (1 in Fig. 6) and withdraw the supporting pin (3 in Fig. 6). Push the draw bar anchor pin (2 in Fig. 6) from the underside of the draw bar frame. Adjust the draw bar for the required length and refit the anchor pin on the required hole on the clevis bar. Raise the draw bar frame and secure it with supporting pin and lock it with lynch pin.

   Refer fig for obtaining two different lengths.Refer below for fig reference number.

   Fig 8 - MF2605

   Fig 9 - MF2615

2. ***HEIGHT :*** The draw bar can be adjusted for different heights in relation to the PTO shat centerline.

   Fig 7 for gives the center line distance of the clevis hole from the PTO shaft end and also the various height adjustments that are possible.

3. ***OFFSET :*** The swinging draw bar can be adjusted in a radial and horizontal plane as shown in

   1st and 2nd Positions

   The adjustment procedure for obtaining the 1st and 2nd Offset position to the left or right from the center position is as follows. (Refer Fig 5)

   Remove the lynch pin (6) and the securing pin(5) and lower the rear end of the frame to the ground. Remove the two hair pins and two

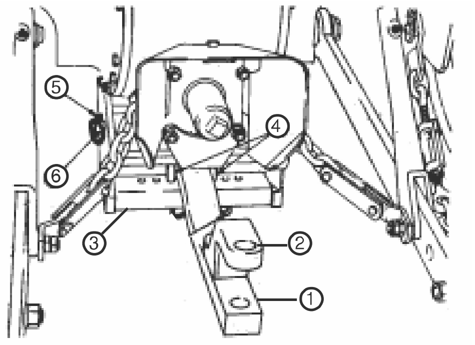


Fig. 5

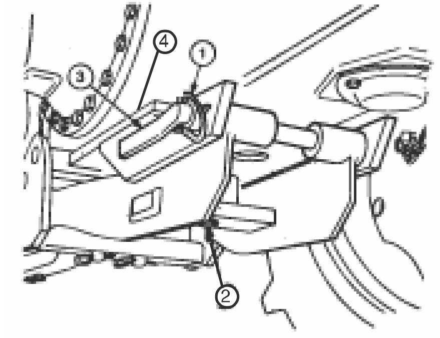
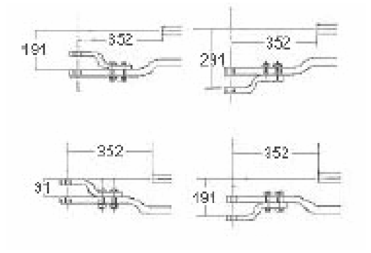


Fig. 6

Anchor pin in 1st Hole



Anchor pin in 2nd Hole

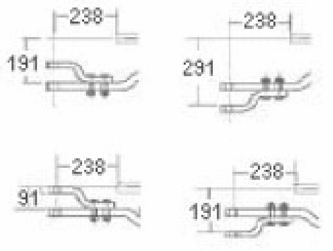


Fig. 7

headed pins (4) and move the draw bar radially to the first or second position selected. Refit the two headed pins and secure them with hair pins. Raise the draw bar frame and fit the securing pin (5) and lynch pin (6).

3rd Offset Position

For third offset position to the left or right, lower the draw bar frame to the ground as detailed above. Remove the two hair pins and headed pins and move the draw bar to the third selected Offset position to the left or right and fit only one headed pin (4) on the last but one hole of the selected position and secure it with hair pin. Raise the Draw bar frame and secure it with securing pin and lynch pin.

Refer Fig 8 and 9 (For MF 2605/2615) for different Offset dimensions possible either to the left or right from the center position for different length of drawbar.

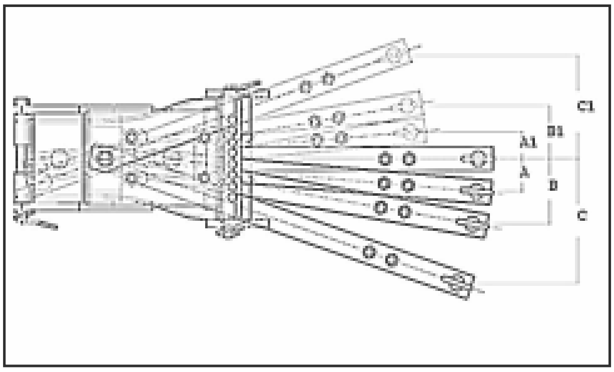


Fig. 8

With the Anchor pin in 1st Hole		With the Anchor pin in 2nd Hole	
A	68	A1	56
B	136	B1	111
C	259	C1	216

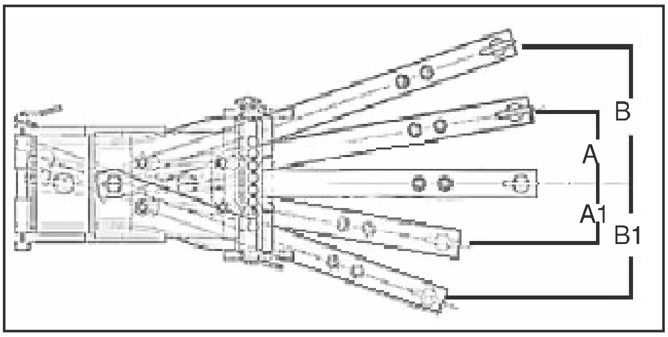


Fig. 9

With the Anchor pin in 1st Hole		With the Anchor pin in 2nd Hole	
A	112.89	A1	96.37
B	249.33	B1	211.75

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SECTION 17

Storage Care

STORAGE CARE

Table of Contents

Operation No.	Description	Page No.
17.1	Tractor … … … …	17A - 3
17.2	Engine … … … …	17A - 3
17.3	Fuel Handling and Storage … … … …	17A - 4

17.1 STORAGE

Tractor

When tractor is kept without use for a longer duration following precautions are to be taken care

1. Tractor should be parked in a weather protected area after complete and thorough cleaning.
2. Tyres should be slightly inflated above the specified pressure and should be protected from direct sunlight.
3. Top-up the Transmission Oil to the full mark on the dipstick. Use the Hydraulic System for sometime and raise the linkage to its transport position. Use a piece of wood as a prop, between the top of the LH Rear Axle Housing and 'crook' formed by the Lift Arm and the Lift Rod to hold the linkage in this position (Fig. 1). Leave the Control Quadrant Levers at transport, the Outer Lever fully down and Inner Lever fully up.
4. Disconnect battery and store in fully charged condition. Before storing the battery, terminals should be treated to prevent corrosion.
5. To prevent the Clutch Lining from bonding itself to the Flywheel, depress the Clutch pedal completely and keep it in depressed condition

17.2 ENGINE

When the Tractor is to be stored for longer duration it is advisable that some measure of protection be offered to the engine, to ensure that it suffers no ill effects during the intervening period before operations recommence.

It is recommended that the following procedure be adopted and applied immediately after the tractor is withdrawn from service:

1. Thoroughly clean all external parts of the engine.
2. Where a preservative fluid is to be used, Drain the fuel system and refill with preservative fluid.
3. Run the engine till it is warm. Stop the engine and drain oil from sump.
4. Drain coolant from the radiator and engine block.
5. Renew full flow filter element.
6. Clean engine breather.
7. Fill sump to correct level with clean new lubricating oil or with a suitable preservative fluid.

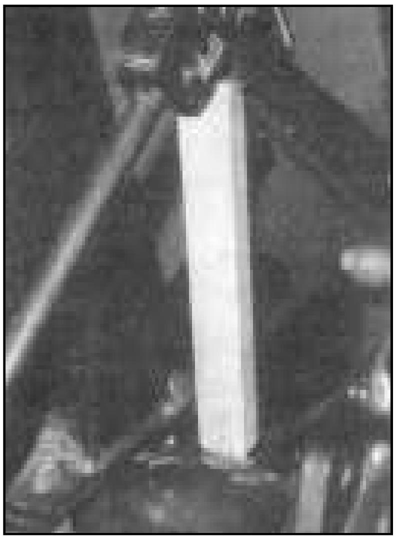


Fig. 1

8. Remove atomisers and spray into cylinder bores 150 ml of lubricating oil divided between the cylinders.
9. Replace atomisers and turn engine slowly over compressions.
10. Remove air cleaner and any intake pipe which may be fitted between the air cleaner and the inlet manifold. Carefully seal manifold port with waterproofed adhesive tape or some other suitable plug.
11. Remove exhaust pipe and seal opening in exhaust manifold.

17.3 FUEL HANDLING AND STORAGE

Utmost care must be taken to keep fuel clean. The following advice is offered to give satisfactory fuel handling and storage :

1. Never use galvanised containers.
2. Never clean the inside of containers, or any components of the fuel system with a fluffy cloth.
3. The size of the bulk storage tank should be such that intervals between drainage and refilling are not too long. 3,000 liters capacity is sufficient for an average sized farm.
4. The storage tank should be under cover and supported on cradles of sufficient height to enable the tractor fuel tank to be filled by gravity and should have a suitable manhole cover to provide access for cleaning (Fig. 2).

   The final outlet drain valve should be located to allow 3 inch (75 mm) settling depth for water and sludge; it should be fed through a detachable filter with 120 mesh screen. There should be a fall of about 0.5 inch per Ft. (40 mm per Metre) towards the sludge drain plug.
5. Drums should be stored under cover, affording adequate protection against entry of water. Drums should be stored at a slight angle, thus allowing any water to run off the top lip. Drums of fuel should not be stacked for long periods before use (Fig. 3).
6. Drums in use outside must have the bung securely screwed down to prevent entry of water.
7. Bulk or drum storage tanks should be allowed 24 hours to settle before use, after delivery or servicing.

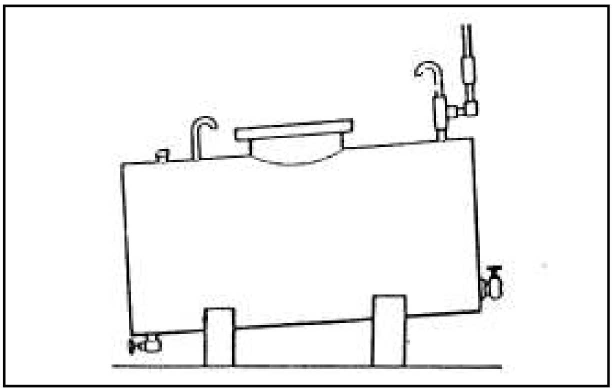


Fig. 2

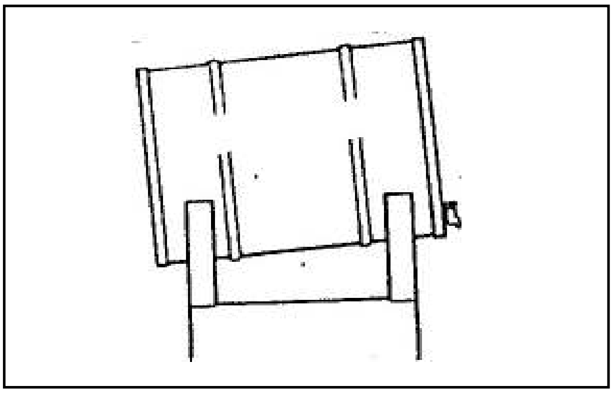


Fig. 3

SECTION 13

Hydrostatic Steering

Table of Contents

Operation No.	Description			Page No.
13 A . 1	Specification			13A - 3
13 A . 2	General Description			13A - 5
13 A . 3	Procedure for oil filling and air bleeding	...	...	13A - 10
13 A . 4	Steering pump removal and refitment	...	...	13A - 11
13 A . 5	Steering pump overhauling	...	...	13A - 12
13 A . 6	Steering pump failures and causes	...	...	13A - 17
13 A . 7	Steering unit removal from tractor	...	...	13A - 18
13 A . 8	Steering unit overhauling	...	...	13A - 21
13 A . 9	Drag link and tie rod overhauling	...	...	13A - 43
13 A . 10	Steering cylinder removal and refitment	...	...	13A - 43
13 A . 11	Steering cylinder overhauling	...	...	13A - 44

13A . 1 - Specification:

Oribitrol steering unit:

Make	Danfoss.
Type code	OSPJ 100 ON.
Nominal displacement	100 cubic centimeter per rev.
Relief valve presuure setting at 1200 engine RPM	140 bar (2030 psi).
Shock valve pressure setting	200 bar (2900 psi).
Reservior capacity	0.65 to 0.75 lts. (1.3 to 1.5 pts).

Special tools:

SER / 278	Holding tool.
SER / 279	Guide ring.
SER / 280	Assembly tool for ‘O’ tring and king ring.
SER / 281	Assembly tool for roto glyd.
SER / 282	Assembly tool for lip seal.
SER / 283	Assembly tool for cardan shaft.
SER / 284	Assembly tool for dust seal.
SER / 298	Hydraulic cylinder ball joint end cover tool.

Bolt torques:

Steering uint mounting plate bolts	27 lbf.ft.(36 Nm).
oribitrol mounting bolts	22 lbf.ft.(30 Nm).
Oribitrol relief valve plug	37 lbf.ft.(50 Nm).
Ball joints	90 lbf.ft.(122 Nm).
Clamp bolt	35 lbf.ft.(47 Nm).
Track adjustment bolt	35 lbf.ft. (47 Nm).
Ball joint nuts	70 lbf.ft (90 Nm).

Recommended grade of oil

BP	....	Terrac Autra C3 10W Vanellus C3 10W Aytran GMMP or DX III
CALTEX	....	RPM Delo 200 Oil 10W Texamatic Fluid - (Dextron III)
CASTROL	....	Castrol II C 310 Agricastrol ATF TQ dextron III Castrol TQ Type A - Suffix A
ESSO	....	Esso torque Fluid 46 Essoulbe XD3 + 10W Esso AIF LASA
MOBIL	....	Mobil ATF 200 Mobil ATF 220 Mobil delvac 1310
SHELL	....	Dextron III Donax TF Rimula X 10 W
TEXACO	....	Torque fluid C3 Ursa super LA SAE 10 W Texamatic 9226 (Dextron III)
TOTAL	....	HTF Type C3 Dextron III Rubia S 10 W

13A . 2 - GENERAL DESCRIPTION:

Hydrostatic steering:

Hydrostatic steering is a full power steering system with no mechanical connection between the steering wheel and tractor wheels. Oil is delivered from the steering pump to the orbitrol steering control unit, which when the steering wheel is turned, directs the required oil flow to the appropriate side of the steering ram(s). When the wheel is stationary the orbitrol unit allows the supply oil to return to the reservoir. The tractor can be manually steered if the power steering mechanism fails, or if the tractor is being moved without the engine running.

The orbitrol steering unit is splined onto the end of the steering column. Hydraulic tubes and hoses connect the unit to the steering ram(s) and the gear pump. The orbitrol steering unit on the small tractors with twin steering rams contains the system pressure relief valve and shock valve.

ORBITROL STEERING UNIT

Neutral Flow. Fig.1.

In the neutral position, oil flows from the hydraulic pump to the steering unit. The holes in the spool align with holes in the sleeve to direct the oil through the centre of the valve into the return flow circuit. The hydraulic lines to the ram cylinder are isolated. Two shock valves and two suction valves are fitted internally to the left and right outlet ports. The shock valve will protect the system between the ram and the orbitrol unit. The suction valve will then allow the other side of the system to compensate for any lack of oil.

Wheel Turning with EngineRunning.Fig.2.

First movement of the steering wheel moves the spool against the leaf springs. This opens the closed centre pressure port and aligns slots in the spool with holes in the sleeve, allowing oil to pass to the hand pump. Further movement of the steering wheel continues to turn the wheel, sleeve and hand pump. Simultaneously the hand pump meters the oil flow and directs it back into the sleeve and spool. The oil re-entering is then directed by slots, in the spool which align with the holes in the sleeve, to direct oil to the headside or roadside of the steering ram (the direction is controlled by steering wheel movement). The oil returning from the steering cylinder is directed, (by the slots in the spool valve aligning with holes in the sleeve) into the return line.

In the line between the inlet and the spool valve, situated internally in the orbitrol unit, is a relief valve (small tractors only). Its function is to protect the pump from excessive pressures. For example, when on full lock, or when the road wheels are against an obstruction. A check valve is fitted in the orbitrol unit in the path of the oil entering from the pump. This is a one-way valve preventing induced peak pressure generated from the road wheels returning to the main pump when steering.

Wheel Turning with EngineStopped.Fig.3.

Should the pressure from the hydraulic pump cease, it is important that steering should still be maintained. For this reason a by-pass valve is situated between the inlet and return galleries inside the orbitrol assembly. When the hydraulic pump is functioning normally, the by-pass valve is held on its seat by the oil pressure, allowing the oil to pass into the spool valve. When the pressure from the hydraulic pump drops, the oil returning from the steering cylinder is allowed to pass the by-pass valve to the inlet side of the spool valve, enabling oil to be passed from one side of the steering cylinder to the other. In this way steering control is maintained at all times.

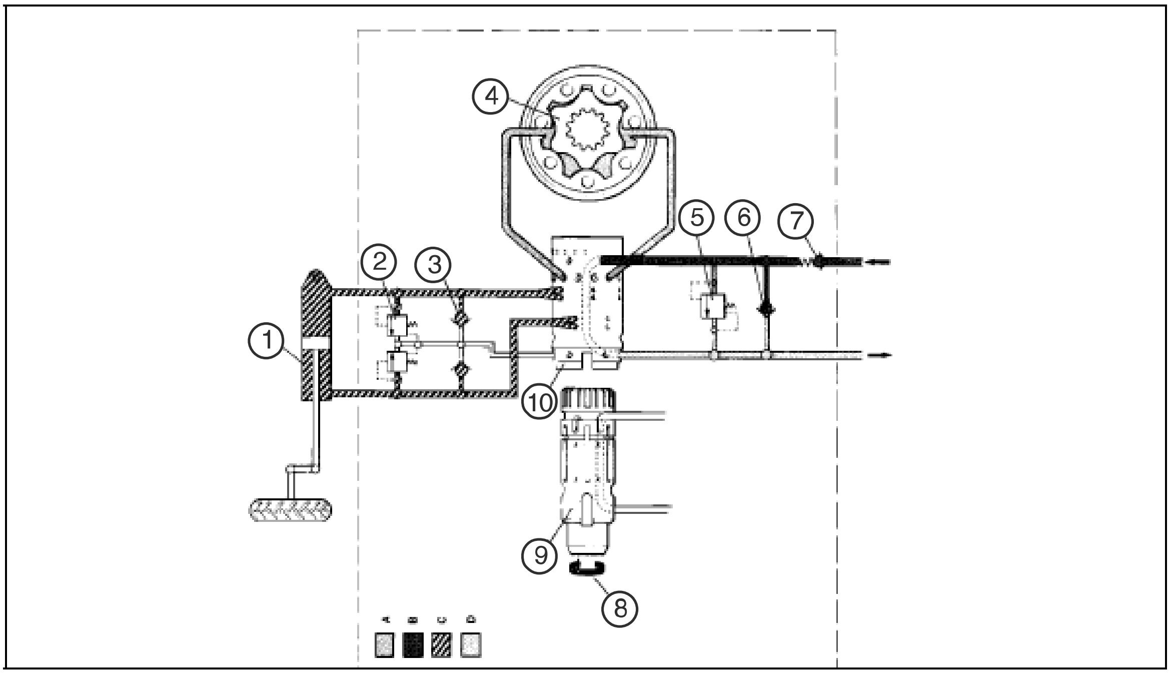


Fig. 1 Orbitrol steering unit circuit - Neutral flow

1. Steering cylinder
2. Shock valves
3. Suction valves
4. Metering valve
5. Relief valve
6. Non return valve
7. Check valve
8. Steering wheel connection
9. Spool valve
10. Sleeve valve

A. Metering valve - static oil
B. Pressure line
C. Steering line - static oil
D. Return oil

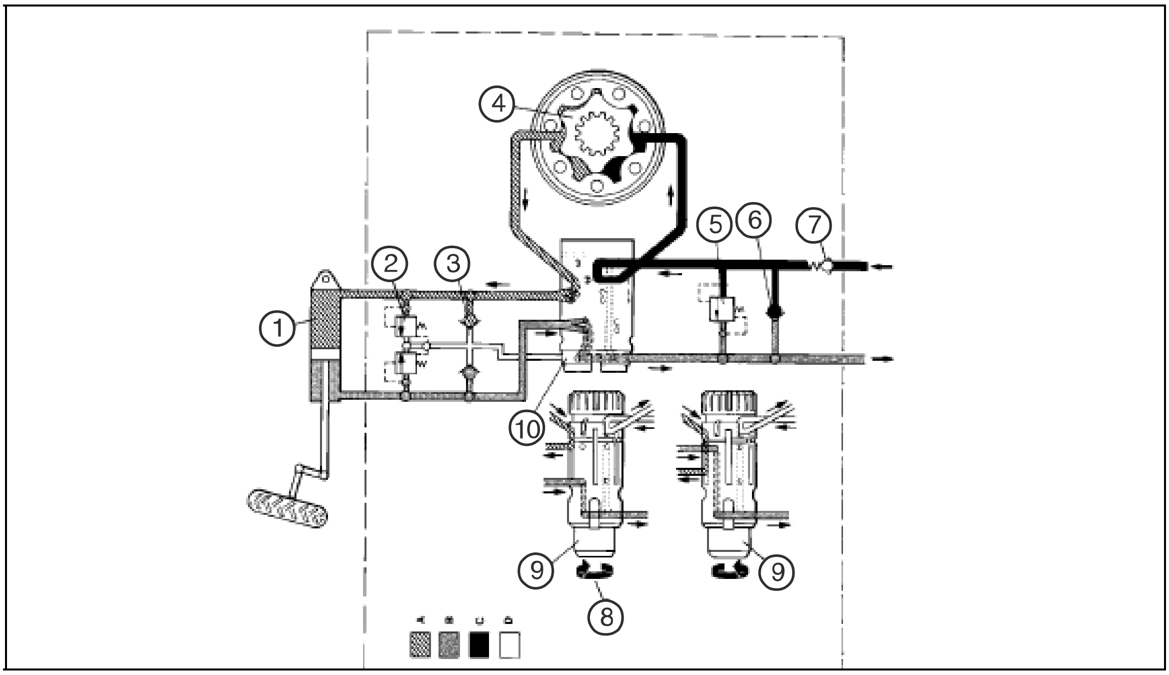


Fig. 2 Orbitrol steering unit circuit - Wheel turning with engine running

1. Steering cylinder
2. Shock valves
3. Suction valves
4. Metering valve
5. Relief valve
6. Non return valve
7. Check valve
8. Steering wheel connection
9. Spool valve
10. Sleeve valve

A. Metering valve - static oil
B. Pressure line
C. Steering line - static oil
D. Return oil

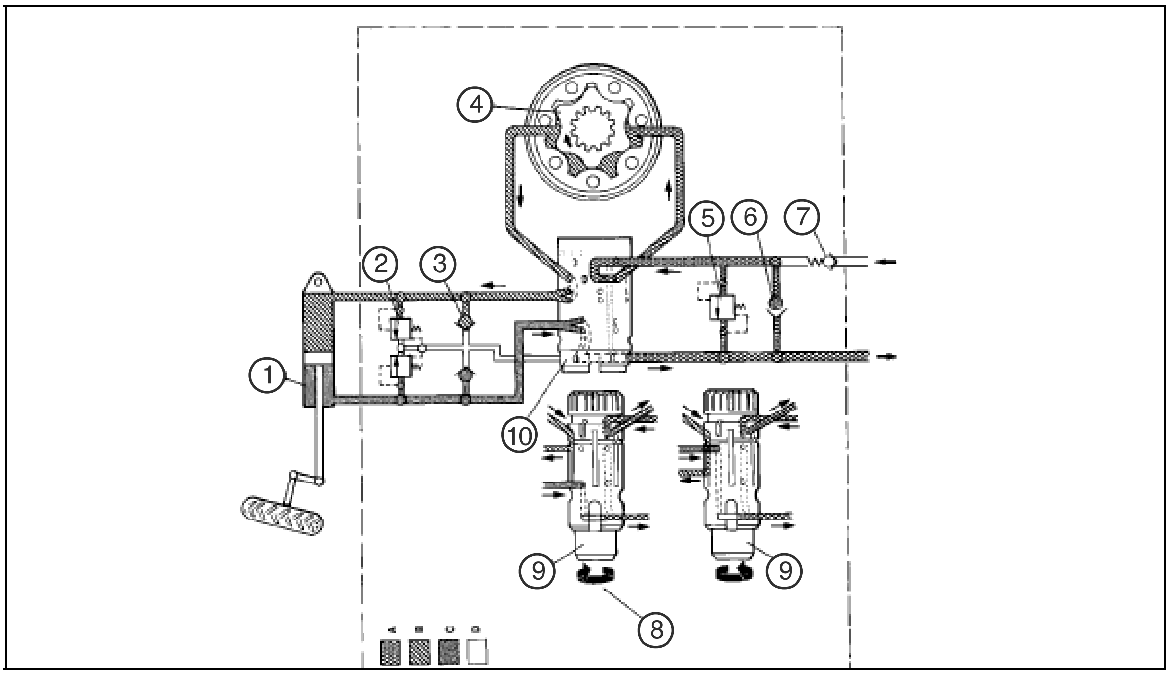


Fig.3 Orbitrol steering unit circuit - Wheel turning with engine stopped

1. Steering cylinder
2. Shock valves
3. Suction valves
4. Metering valve
5. Relief valve
6. Non return valve
7. Check valve
8. Steering wheel connection
9. Spool valve
10. Sleeve valve

A. Metering valve - static oil
B. Pressure line
C. Steering line - static oil
D. Return oil

TYPICAL STEERING LAYOUT FOR 2WD

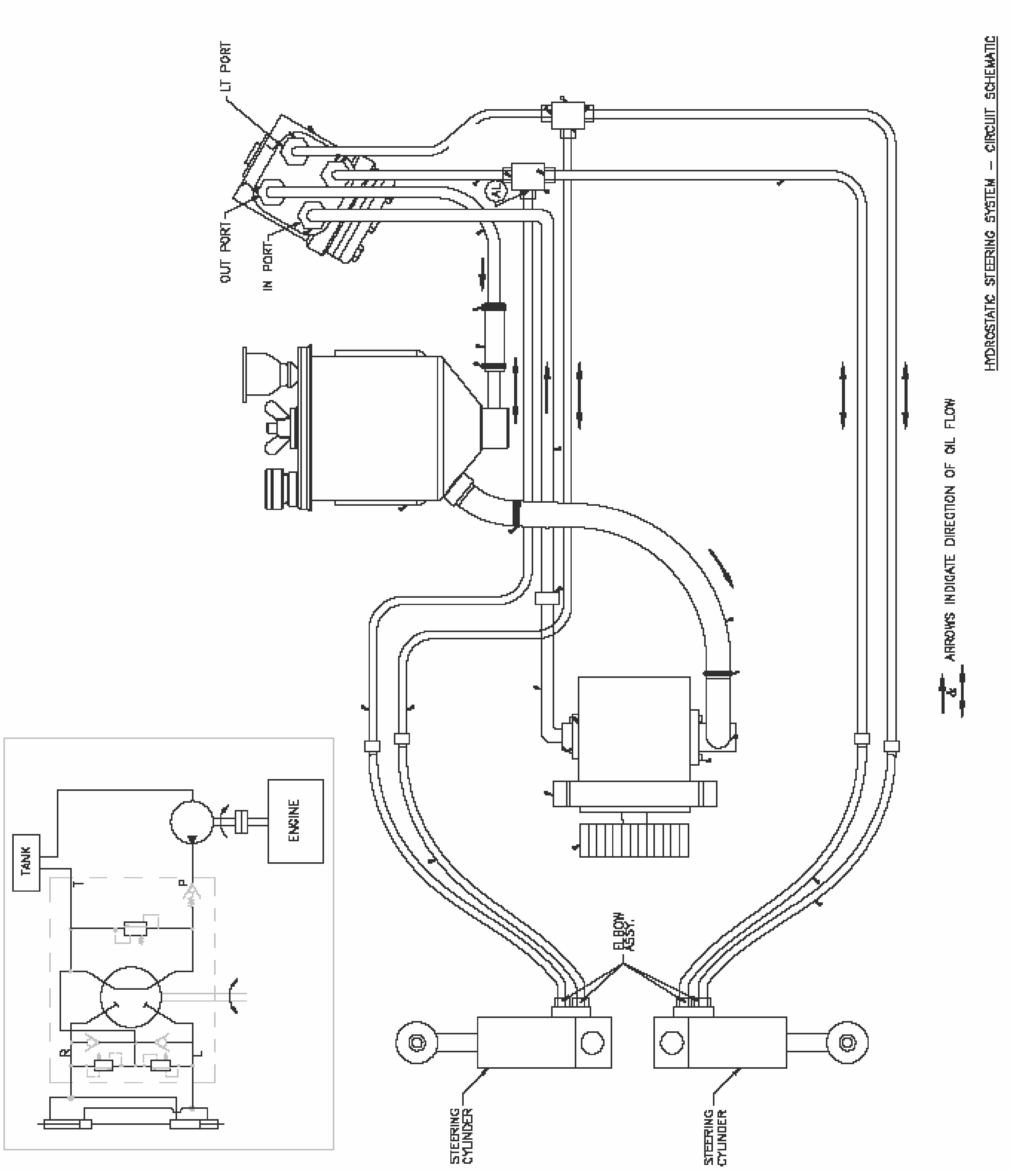

HYDROSTATIC STEERING SYSTEM – CIRCUIT SCHEMATIC
ARROWS INDICATE DIRECTION OF OIL FLOW
LT PORT
OUT PORT
IN PORT
AL
ELBOW ASSY.
STEERING CYLINDER
STEERING CYLINDER
TANK
ENGINE
T
P
R
L

Fig 4

TYPICAL STEERING LAYOUT FOR 4WD

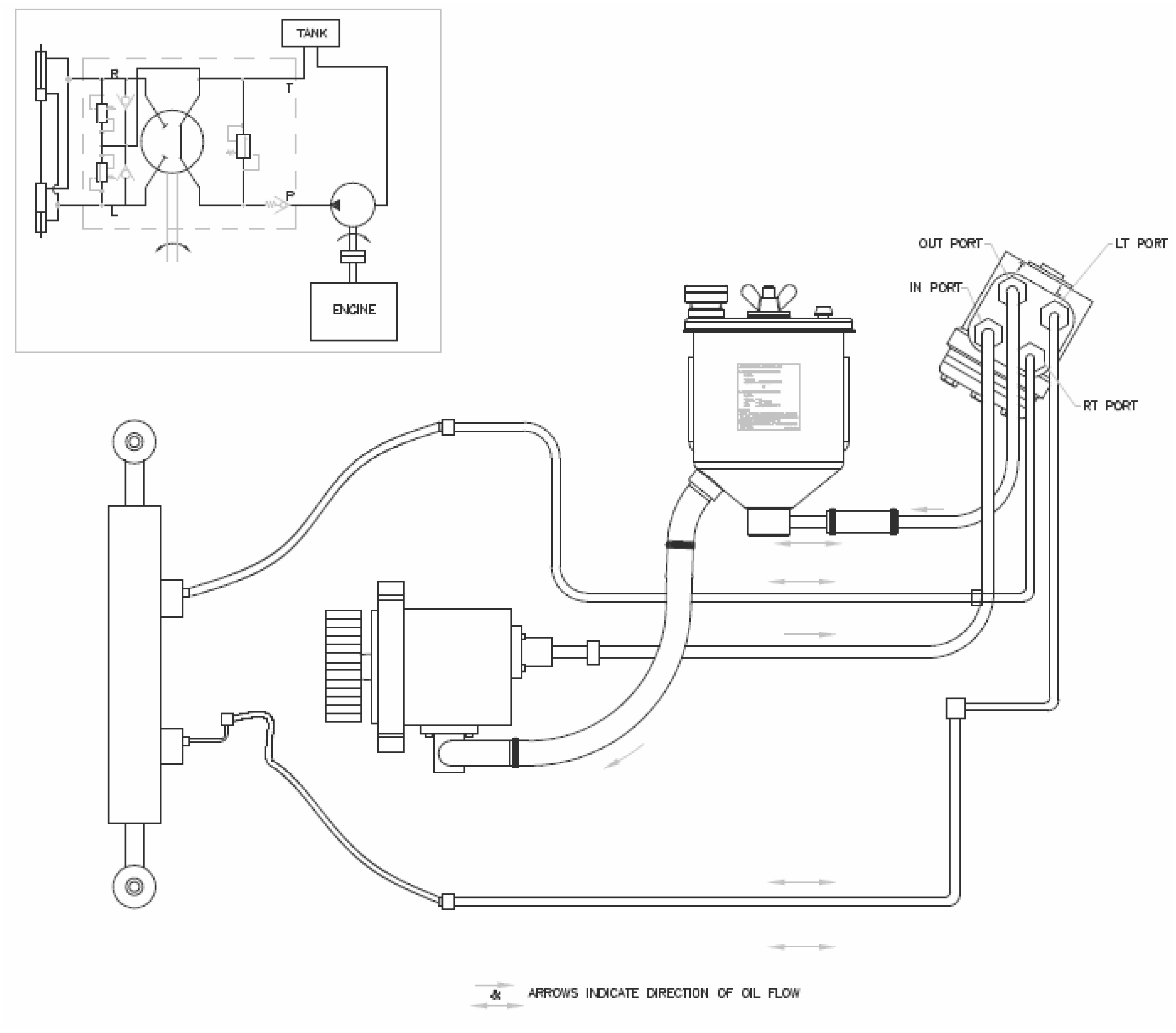

TANK
R
T
P
L
ENGINE
OUT PORT
LT PORT
IN PORT
RT PORT
& ARROWS INDICATE DIRECTION OF OIL FLOW

Fig 5

13A . 3 PROCEDURE FOR OIL FILLING AND AIR BLEEDING IN HYDROSTATIC STEERING UNIT.

CAUTION:

Do not remove the filler plug from the pump when the engine has been running for a long period as the oil in the pump will be hot and can cause severe burns if it comes into contact with the skin.

Air removal

Procedure

1. Remove the filler plug.
2. Fill the pump reservoir with clean oil to the plug level.
3. Replace the filler plug.
4. Start the engine and run it at 900 rev/min for approximately 30 seconds.
5. Rotate the steering to the left and right full lock positions.
6. Switch off the engine and refill the reservoir to the plug level.
7. Run the engine at 1200 rev/min.
8. Repeat procedure 5.
9. Leave the steering at full left lock and full right lock for approximately 10 seconds each time.
10. Repeat procedure 9, three times.
11. Switch off the engine and check all unions for leaks. If leaks are discovered, correct the fault and repeat the whole operation.
12. Tighten the filler plug to a torque of 106 lbf.inch (12 Nm).

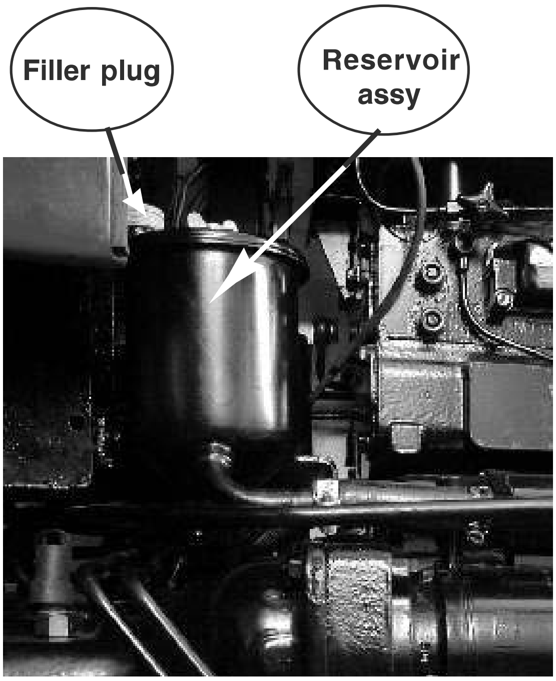


Fig. 6

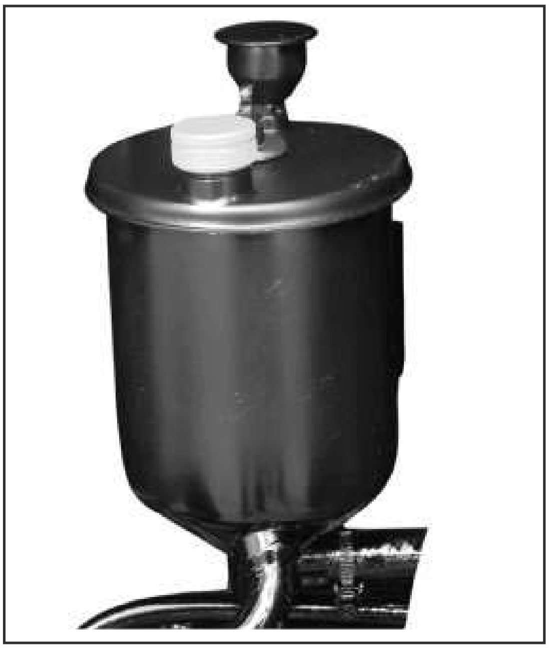


Fig 7

STEERING PUMP:

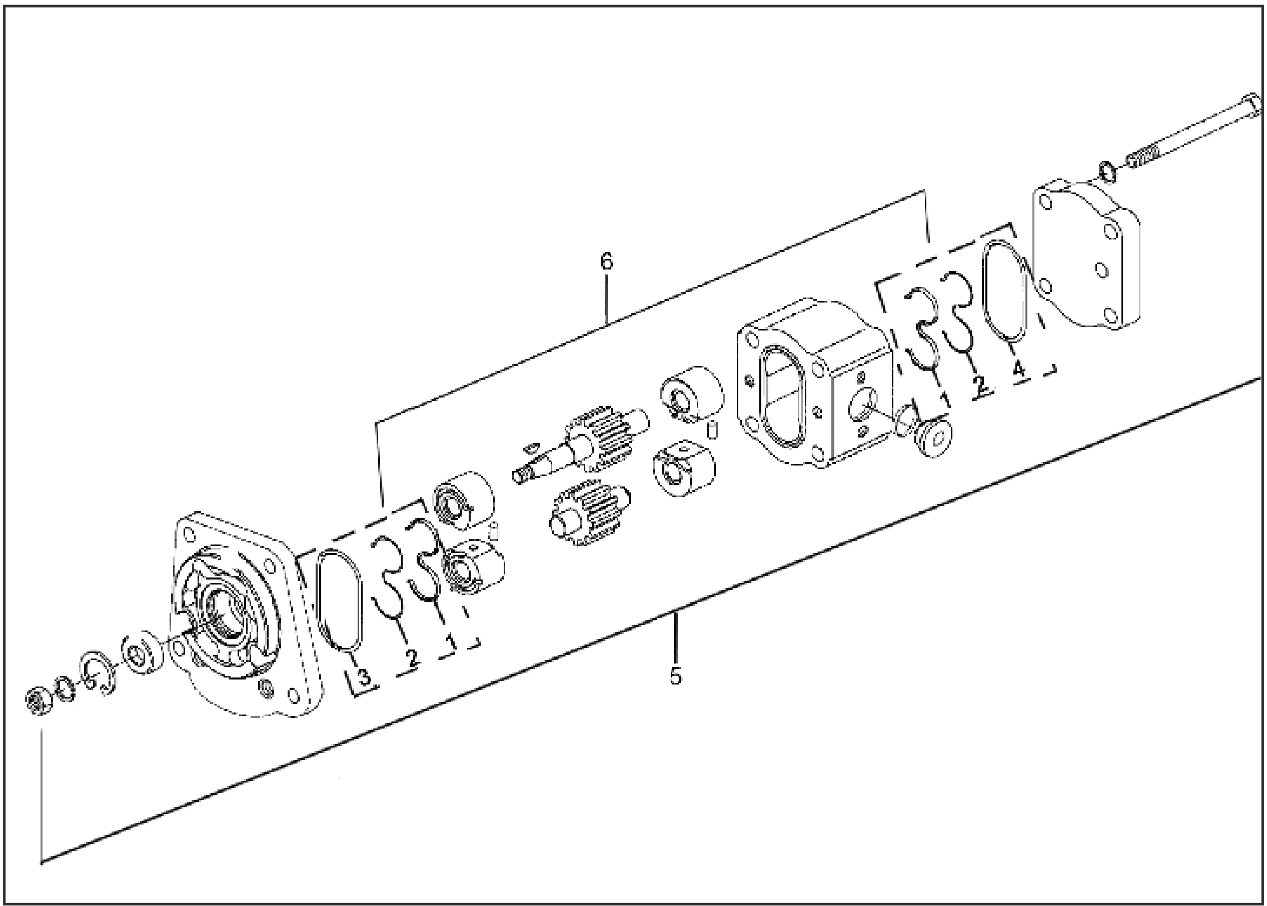


Fig 8 - Steering hydraulic gear pump exploded view

1.Seal ring 2.Support ring 3.Seal ring 4.Seal ring 5.MICO - Steering pump

6.Seal kit - Hyd gear pump (Includes items 1 to 4).

13 A . 4 - Steering pump:

Removal and refitment :

Removal:

1. Park the vehicle on level ground and apply parking brake .
2. Remove the ignition key from the tractor.
3. Disconnect the hydraulic pipe to the steering unit.
4. Disconnect the hydraulic pipe return to the pump.
5. Remove the four bolts securing the pump to the timing case.
6. With draw the pump assembly from the engine.
7. Remove the pump gear by using bearing puller.

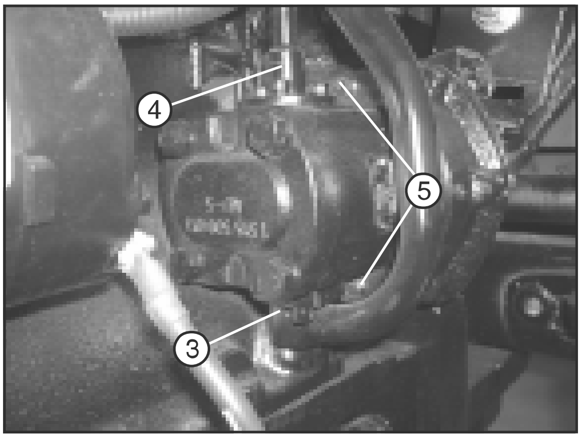


Fig 9

Refitment:

8. Reverse the procedure 1 to 7 except:

   a. Tighten the mounting bolts at a torque of 36 Nm (27 lbs.ft).

9. Refill the transmission oil and prime the system as described in section 13 A . 3 .

13A . 5 - Steering Pumps
Dis-Assembly & Re-assembly Procedure

1. Fix the fixture plate and fixture rod on the universal Vice.

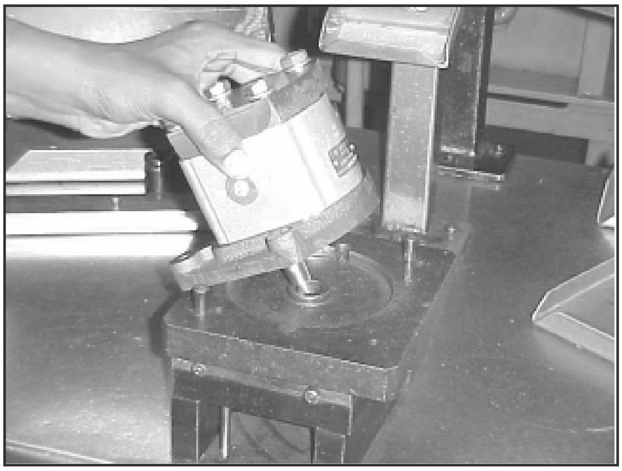


Fig 10

2. Mount the pump such that the drive gear shaft is towards the vice

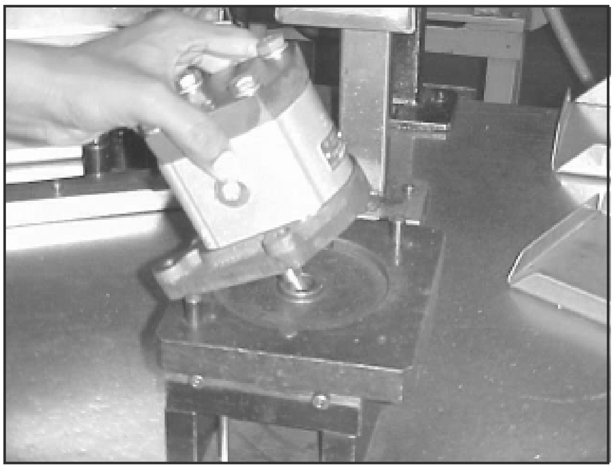


Fig 11

3. Loosen 4 hex.bolts & remove bolts

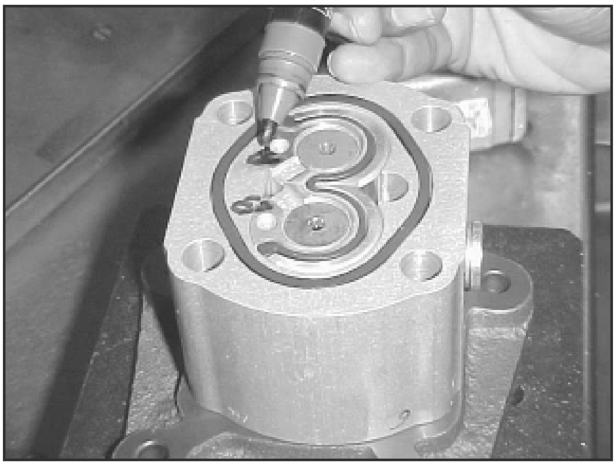


Fig 12

4. Remove the end cover, mark A & B on bearing. bush On the end cover side.
   Bush on drive gear -A
   Bush on driven - B
   (this is to avoid inter-changing during Re- Assembly)

5. Remove housing along with bearing bushes & gears from mounting flange. Mark C & D on drive & driven side bush respectively
6. Remove all seals. Dis assemble bearing bushes and gears from the housing. Do not use hammer or force to separate the components.
7. Remove the mounting flange from the fixture plate. Mount it upside down. Remove circlip.
8. Remove the shaft seal
9. Clean all the components with a suitable cleaning media. Remove burrs from housing.

   Do not use file to deburr, use a sharp tool to scrape, such as a triangular scraper.

   Do not use cotton waste or cloth for cleaning/ wiping.
10. Examine the housing, bearing bush surfaces and the bearing sleeves for wear due to contamination etc.
11. If no severe wear is seen in the housing and bearing bushes, re-assemble the pump with new seals as per re-assembly procedure and use the pump.

    If the wear is severe, the pump can not be repaired.

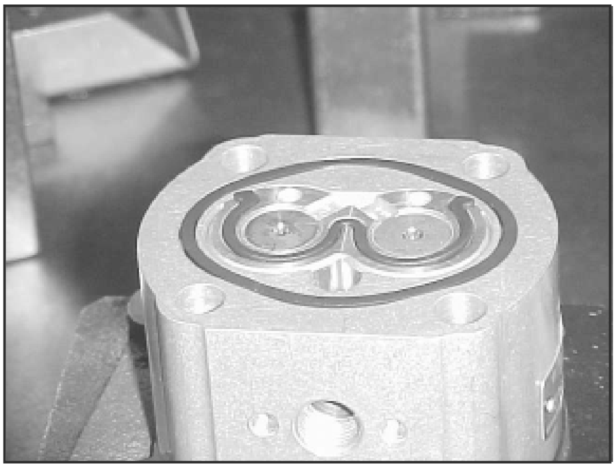


Fig 13

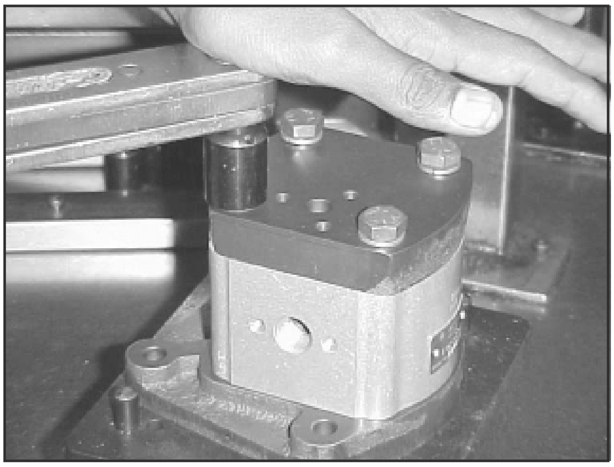


Fig 14

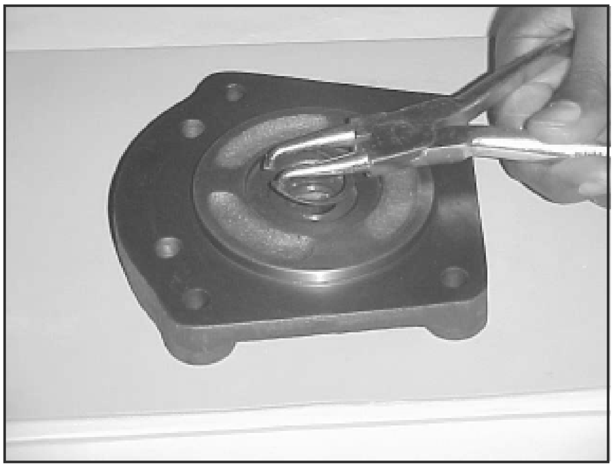


Fig 15

HYDRAULIC GEAR PUMPS

Re-assembly Procedure

1. Take care to see that bearing bushes and the gear shafts are assembled correctly (Observe the A,B,C, & D marks made earlier)

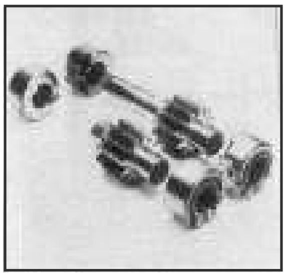


Fig 16

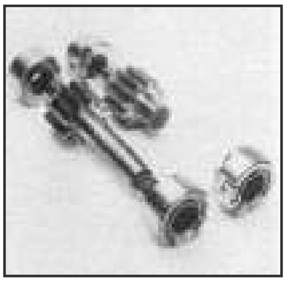


Fig 17

2. Assemble bearing bushes and gear shafts in the housing. See also the exploded view of the pump.

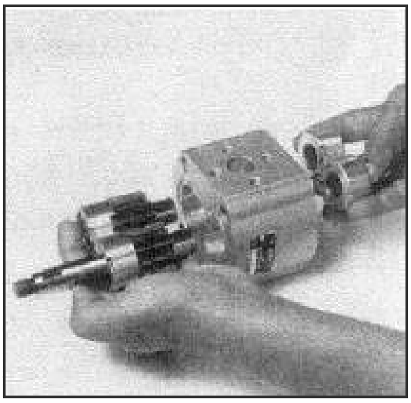


Fig 18

3. Place the assembly on the table with drive gear shaft projecting up. Fix the seals on the mounting flange side. Assemble the mounting flange.

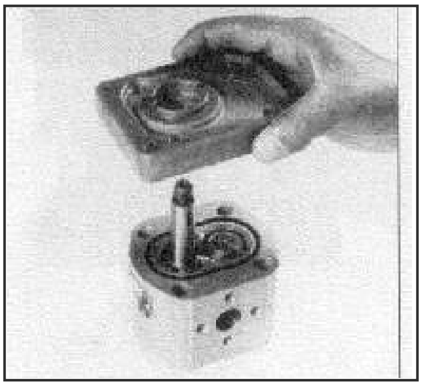


Fig 19

4. Hold the mounting flange, housing assembly and the bearing bushes together, turn and keep it back on the fixture plate with drive gear shaft towards the vice.

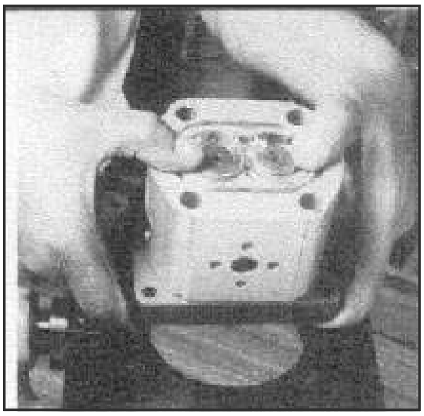


Fig 20

5. Fix the mounting flange using screws and nuts on the fixture plate. Assemble seals on the end cover side. Assemble the end cover.

6. Hand tighten the pump assembly with 4 hexagon. bolts and spring washers. Turn the fixture plate so that drive shafts is horizontal.

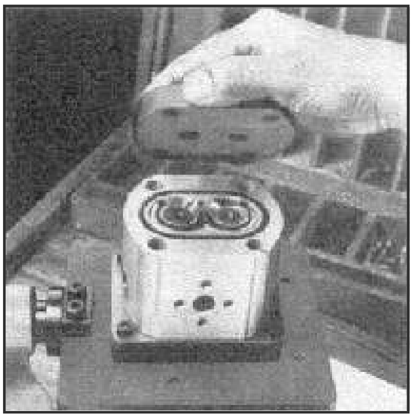


Fig 21

7. Insert the centering bush fully through the drive shaft, with appropriate mark on the bush towards the pump. Tighten the hexagon bolts. Remove the centering bush. This is to ensure alignment of shaft and the spigot.

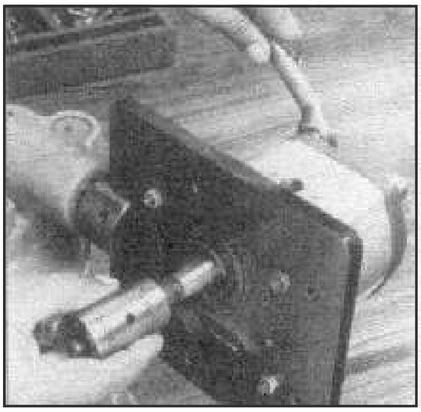


Fig 22

8. Turn the fixture plate back to assembly position. Tighten 4 hex. Bolts further with a torque wrench. 37 + 7 lbf.ft. (50+10 Nm).

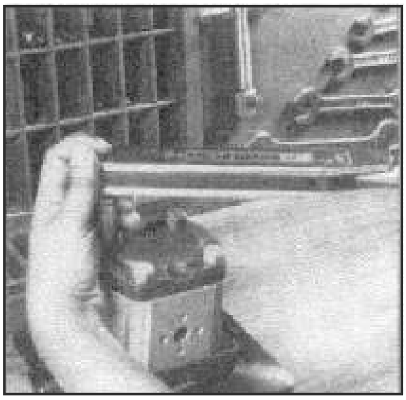


Fig 23

9. Remove pump from fixture plate, place the pump with drive shaft projecting upwards on the base of hand press. Using same centering bush and with appropriate mark on the bush towards the pump, press the shaft seal over the pump drive shaft.

10. Fix the circlip in the groove. Ensure circlip is located properly in the groove.

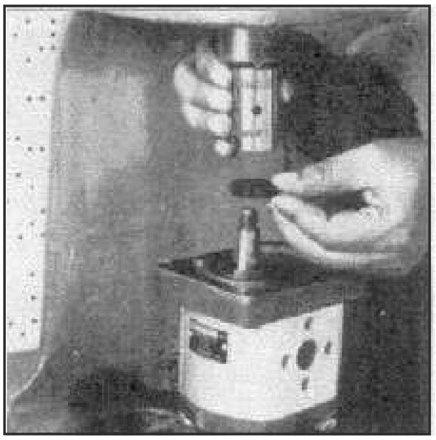


Fig 24

13A . 6 - HYDRAULIC GEAR PUMPS

Causes of Failure - Drive Faults

1. Distorted Key way due to a badly fitting Internal taper.

2. Fretting corrosion and broken drive shaft due to a badly fitting internal taper.

3. Sheared key due to :

   a) Badly fitting internal taper;

   b) Incorrectly tightened drive shaft nut.

4. Rear bushing of drive shaft badly worn due to end thrust from the pump drive.

5. Deep grooves in the pump body on the suction side (partly extending to the delivery side) due to severe contamination of Hydraulic oil.

6. Surface scoring of the pump body on the suction side (partly extending to the delivery side) due to contamination of the hydraulic oil - initial stage of failure.

7. Worm-like grooving in the outer surface of the bushing due to oil contamination.

8.1 Erosion due to oil contamination at the line of contact.

8.2 Concentric contamination grooving in root circle diameter.

9. Wear due to oil contamination. Gap to straight edge visible.

10. Scored bearing journal due to oil contamination.

11. Wear Zone due to contamination

12. Bronze showing through: Teflon coating worn away by scoring of gear wheel bearing journal. (oil contamination)

13. End seizure due to high temperature in the pump and bearing failure due to contamination wear. Advanced stage of failure. Similar effects are produced by Hydraulic overloading and oil temperature.

14. Severe bearing seizure and End seizure due to contamination wear and/or Hydraulic Overloading and/or oil over temperature. Total failure stage.

15. Suction side of pump body worn by the pump gear wheels due to bearing failure. Total failure stage.

16. Total failure of the bearing bushing and journal due to contamination wear an/or hydraulic overloading and/or oil temperature.

17.Support ring melted, seal hardened by oil over temperature.

18. Same as in 17, oil over temperature.

19. Cavitation attack of the end faces (air in oil)

20. Cavitation `attack of the pump body.

13A . 7 PROCEDURE FOR DISMANTLING HYDRAULIC STEERING UNIT FROM TRACTOR

1. Lift hood/Bonnet and disconnect battery terminal.
2. Remove steering cap and remove steering wheel.
3. Disconnect oil pressure pipe from gauge.
4. Remove fuel cut off knob and disconnect fuel cut off rod from Inst. Panel.
5. Disconnect Hour meter cable connection at meter end.
6. Remove hand throttle lever bracket .
7. Remove Inst. Panel mounting bolts on top and sides and lift Instrument panel from steering column and rest against fuel tank.
8. Remove reservoir hoses and drain oil into a clean container.
9. Remove the steering reservoir.
10. Disconnect pipes from P,T,L,R, points Fig. 1.
11. Disconnect pipes from ‘T’ joints Fig. 2.
12. Remove adapters from the P,T,L & R points.
13. Remove steering housing top cover (4 bolts) and disconnect ‘L’ bracket at rear of steering unit.
14. Remove steering unit with column by manipulating it out from the Inst. Panel.
15. Remove steering column mounting bolts and isolate steering unit.

    For assembly follow the reverse procedure of dismantling.

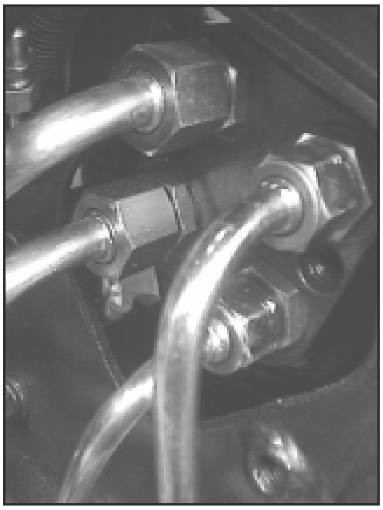


Fig 25

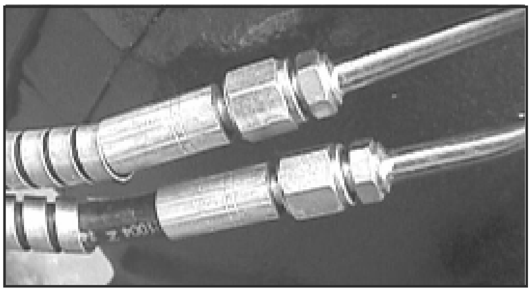


Fig 26

STEERING UNIT

Exploded view OSPJ 100 ON :

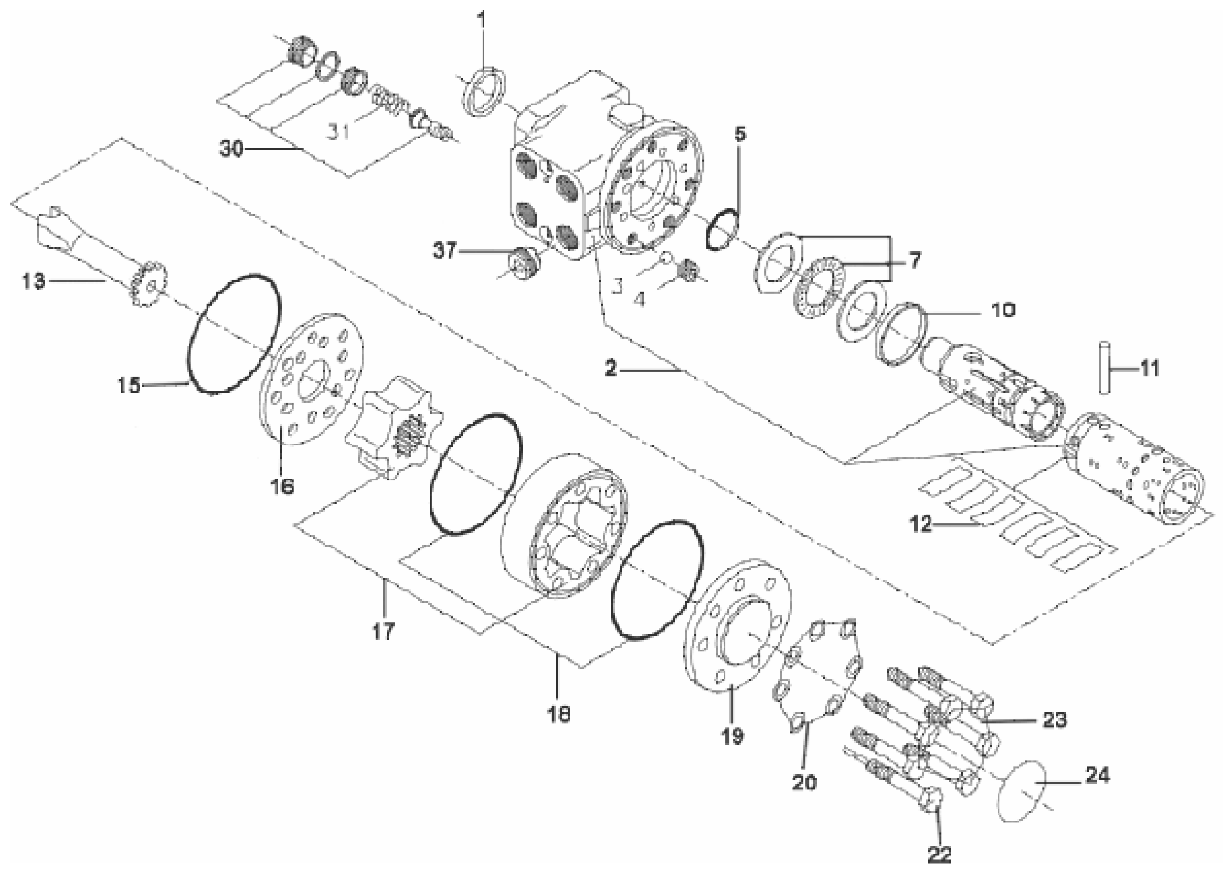
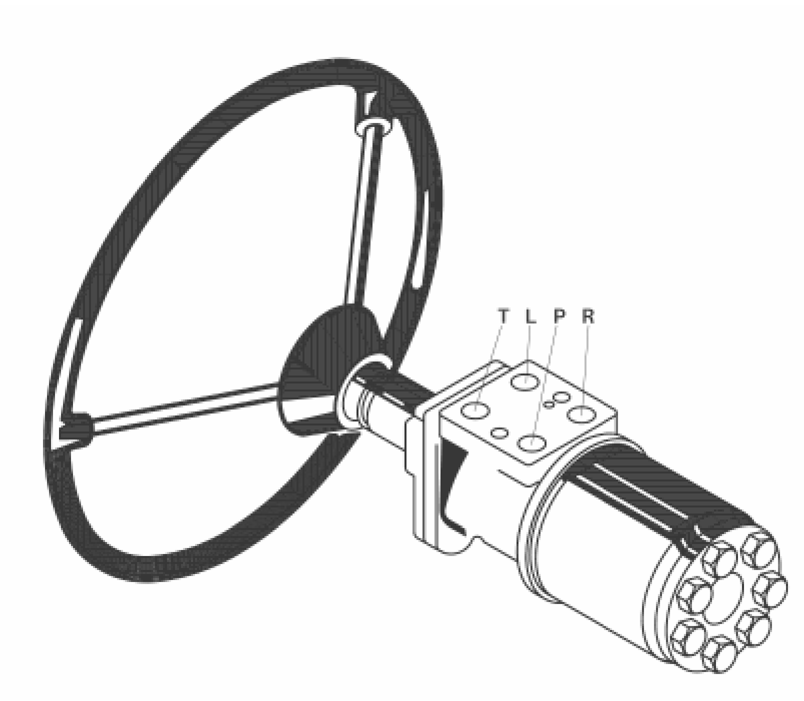


Fig 27

1	Dust seal ring.
2	Housing spool/sleeve.
3	Ball dia 8.5 mm.
4	Thread bushing.
5	O-ring/rotoglyd.
7	Bearing assly.
10	Ring.
11	Cross pin.
12	Set of springs .
13	Cardan shaft.
15	O-ring.
16	Distributor plate.
17	Gear wheel set.
18	O-ring.
19	End cover.
20	Washer .
22	Screw with pin.
23	Screw .
24	Name plate.
30	Pressure relief valve
31	Spring for relief valve
37	Check valve.

Max. tightening torque and hydraulic connections



L : Left Port
R : Right port
T : Tank
P : Pump

Fig 28

Screwed connection	Max : tightening torque daNm (ibf in)			
	With cutting edge	With copper washer	With aluminium washer	With O-ring
G 1/4	4 (350)	2 (180)	3 (270)	-
G 3/8	6 (530)	2 (180)	5 (440)	-
G 1/2	10 (900)	3 (270)	8 (700)	-
7/16-20 UNF	-	2 (180)	-	-
3/4-16 UNF	-	6 (530)	-	-
M12x1,5	4 (350)	2 (180)	3 (270)	2 (180)
M 18 x 1.5	7 (620)	2 (180)	5 (440)	5 (440)
M 22 x 1.5	10 (900)	3 (270)	8 (700)	7 (620)

13 A . 8 - STEERING UNIT

Overhauling

Dismantling of steering unit:

1. Dismantle steering column from steering unit and place the steering unit in the holding tool (SER278).Screw out the screws in the end cover (6-off plus one special screw).

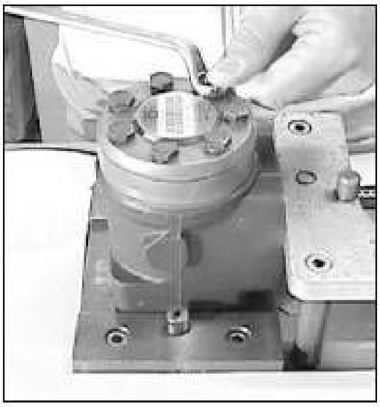


Fig 29

2. Remove the end cover, sideways

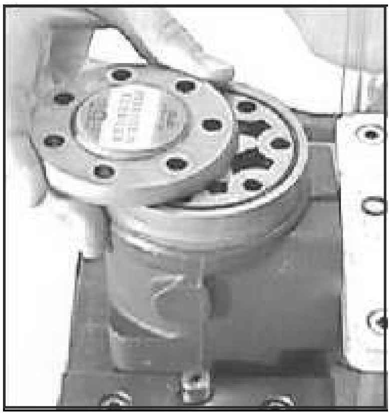


Fig 30

3. Lift the gearwheel set (with spacer if fitted)off the unit.Take out the two o-rings.

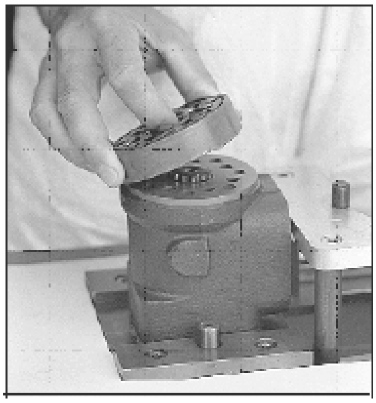


Fig 31

4. Remove cardan shaft.

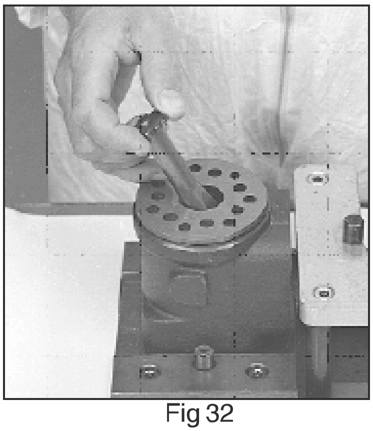


Fig 32

5. Remove distributor plate.

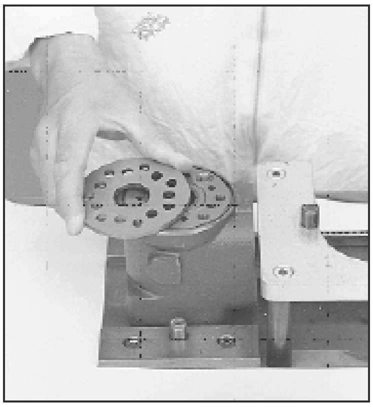


Fig 33

6. Screw out the threaded bush over the check valve.

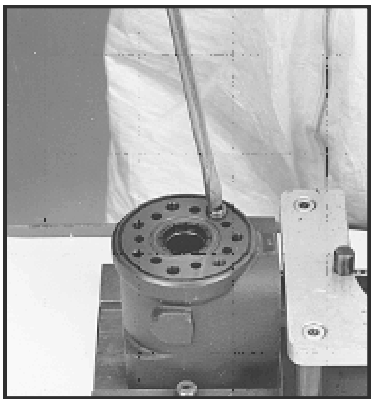


Fig 34

7. Remove ‘O’ -ring.

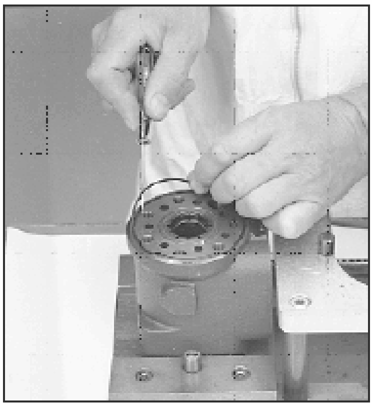


Fig 35

OSPJ 100 ON:

8. Shake out the check valve ball and suction valve pins and balls.

   Note:*On some pins in the OSPJ 100 ON there are two springs.Replace these pins prior to the reassembly.*

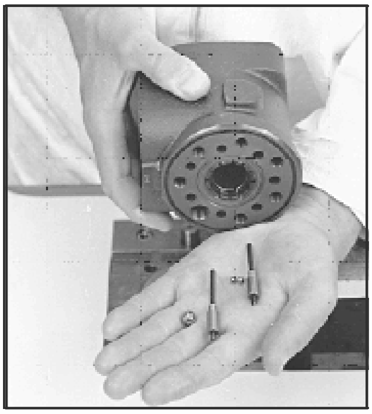


Fig 36

10. Take care to keep the cross pin in the sleeve and spool horizontal.The pin can be seen through the open end of the spool.Press the spool inwards and the sleeve,ring,bearing races and needle bearing will be pushed out of the housing together.

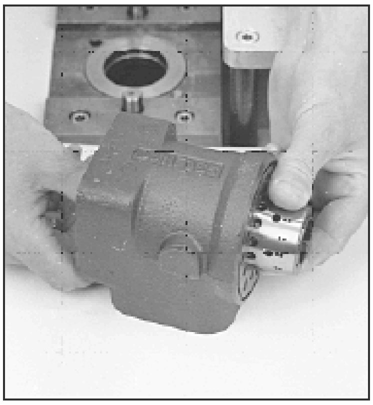


Fig 37

11. Take ring,bearing races and needle bearing from sleeve and spool.The outer (thin)bearingrace can sometimes “stick “ in the housing,therefore check that it has come out.

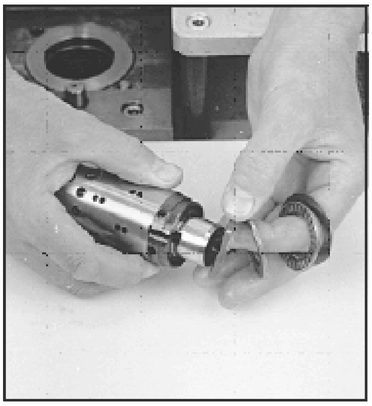


Fig 38

12. Press out the cross pin.Use the special screw from the end cover. Note next point / paragraph

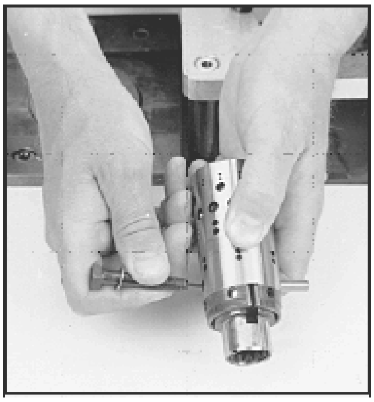


Fig 39

A small mark has been made with a soap stone on both spool and sleeve close to one of the slots for the neutral position springs.

If the mark is not visible,make a mark (non abrasive mark that can be wipe off) of your own on sleeve and spool before the neutral position springs are dismantled.

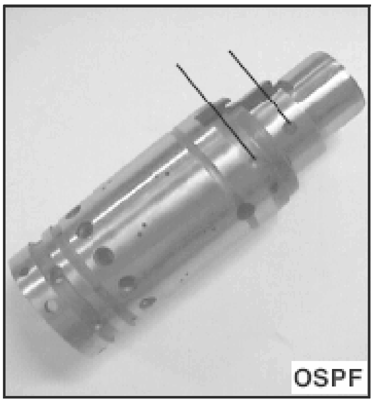


Fig 40

13. Carefully press the spool out of the sleeve.

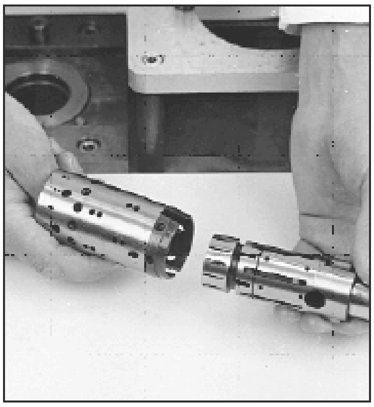


Fig 41

14. Press the neutral position springs out of their slots in the spool.

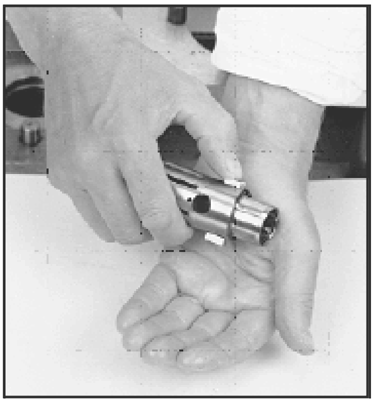


Fig 42

15. Remove dust seal and o-ring / kin-ring / RotoGlyd.

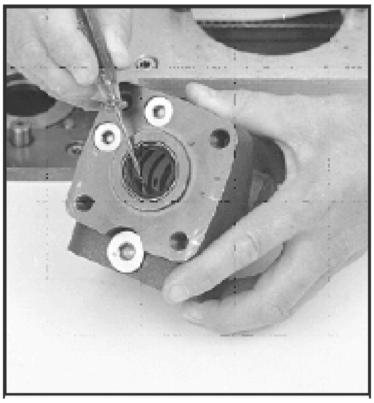


Fig 43

Dismantling the shock valves for OSPJ 100 ON

16. Remove plugs from shock valves using a 6 mm hexagon socket spanner.

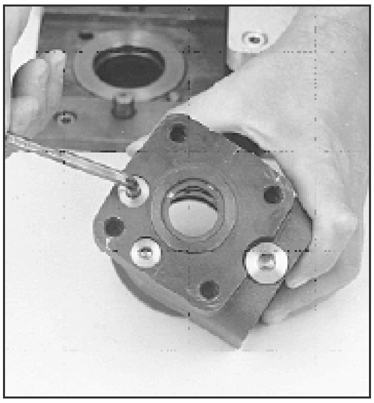


Fig 44

17. Remove seal washers (2-off).

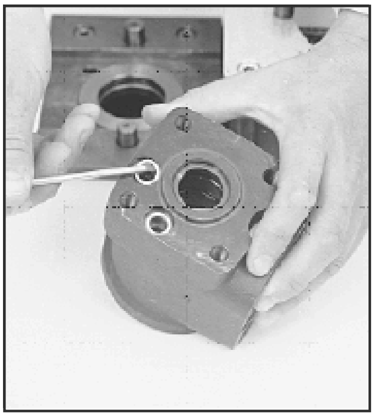


Fig 45

18. Unscrew the setting screws using a 6 mm hexagon socket spanner.

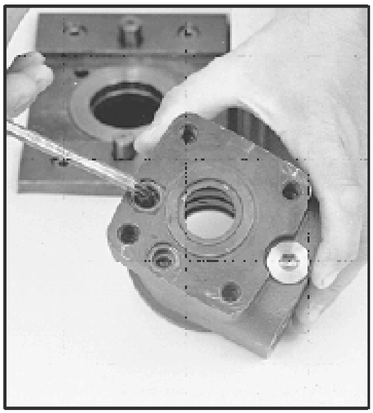


Fig 46

19. Shake out the two springs and two valve balls into your hand.The valve seats are bonded into the housing and cannot be removed.

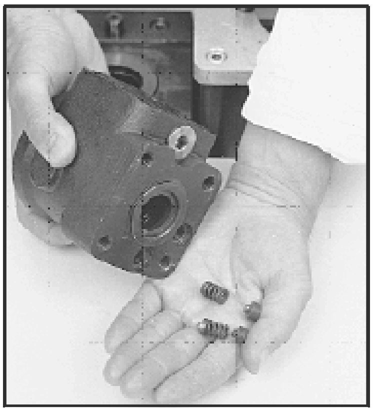


Fig 47

20. The shock valves are now dismantled.

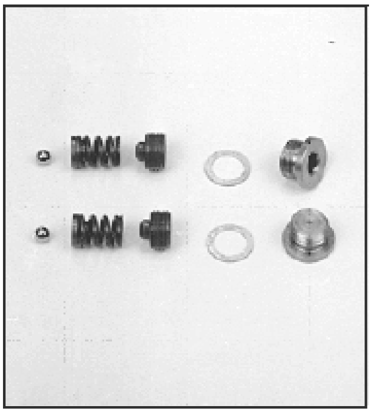


Fig 48

21. Screw out the plug using and 8 mm hexagon socket spanner. Remove seal washers.

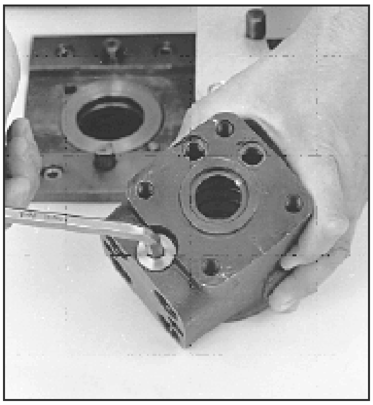


Fig 49

22. Unscrew the setting screw using an 8 mm hexagon socket spanner.

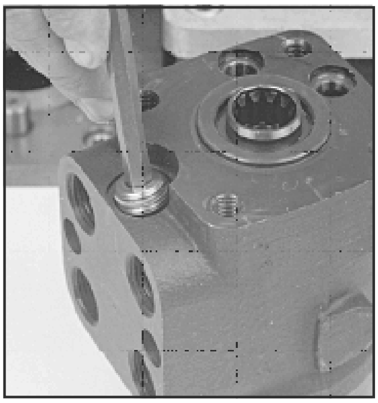


Fig 50

23. Shake out spring and piston.The valve seat is bonded into the housing and cannot be removed.

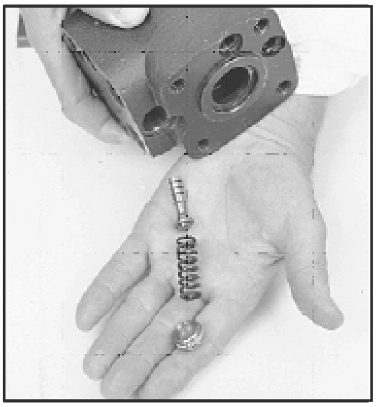


Fig 51

24. The pressure relief valve is now dismantled.

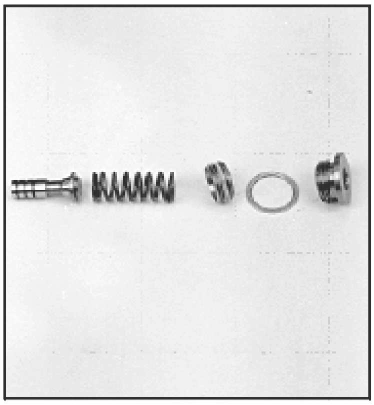


Fig 52

Dismantling the pressure relief valve (cartridge) for OSPJ 100 ON

25. Screw out the pressure relief valve using a 8 mm hexagon socket spanner.Remove the seal ring.If the valve is defective it must be replaced

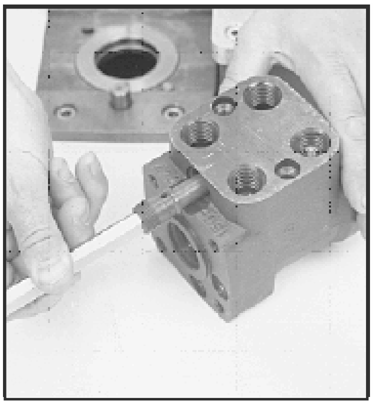


Fig 53

26. The pressure relief valve is now dismantled.

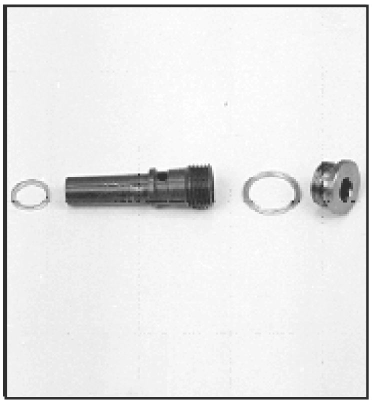


Fig 54

27. The steering unit OSPJ 100 ON is now completely dismantled.

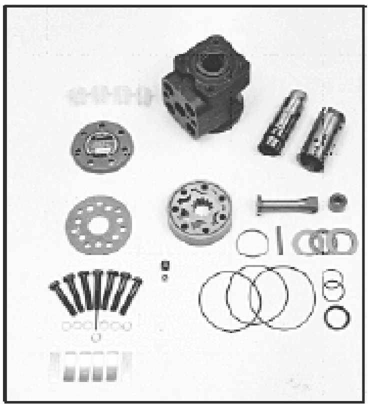


Fig 55

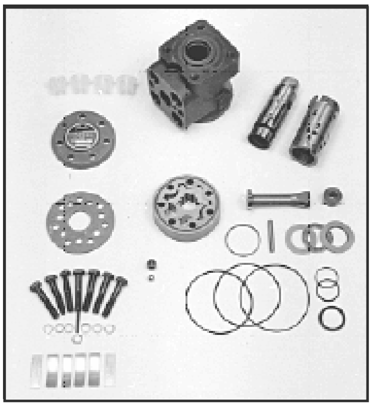


Fig 56

28. The steering unit OSPJ 100 ON is now completely dismantled. Replace these pins prior to the reassembly.(Refer arrow).

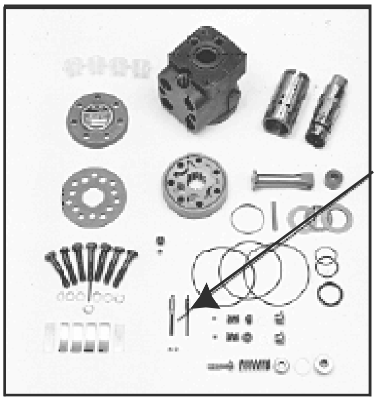


Fig 57

Cleaning

Clean all parts carefully in Shellsol K or similar parts cleaning solvent.

Inspection and replacement

Replace all seals and washers.Check all parts carefully and make any replacements necessary.

Lubrication

Before assembly,lubricate all parts with dextron oil.

ASSEMBLING:

29. Place the two flat neutral position springs in the slot.

    Place the curved springs between the flat ones and press them into place.

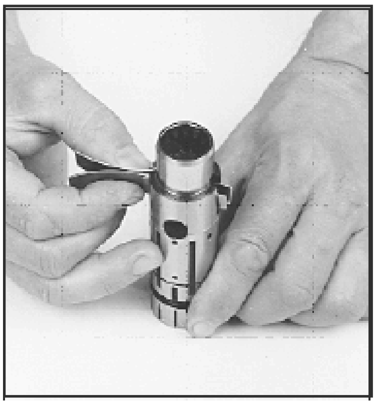


Fig 58

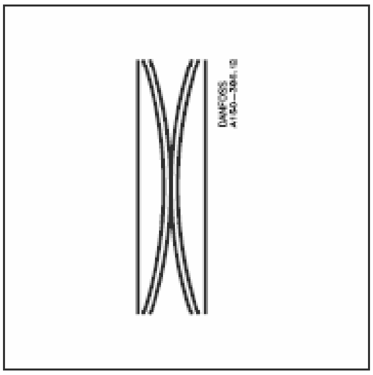


Fig 59

30. Line up the spring set.

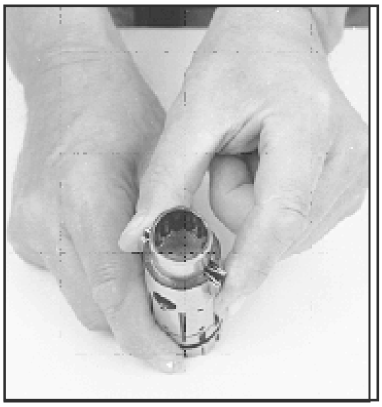


Fig 60

31. Guide the spool into the sleeve.Make sure that spool and sleeve for OSPJ 100 ON are placed correctly in relation to each other .

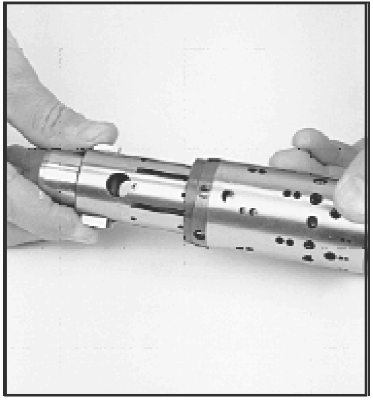


Fig 61

Note:

OSPJ 100 ON :

32. *When assembling spool and sleeve only one of two possible ways of positioning thespring slots is correct.*

    There are three slots in the spool and three holes in the sleeve in the end of the spool / sleeve opposite to the end with spring slots.Place the slots and holes opposite each other so that parts of the holes in the sleeve are visible through the slots in the spool.

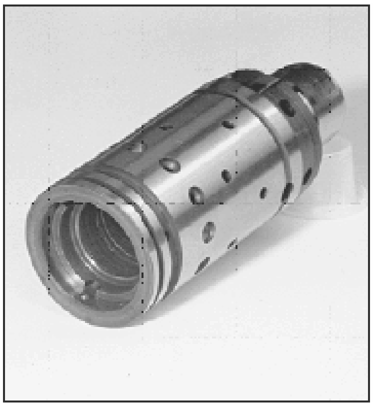


Fig 62

OSPJ 100 ON :

33. *Assemble the spool /sleeve and make sure the marks on spool and sleeve are opposite each other.*

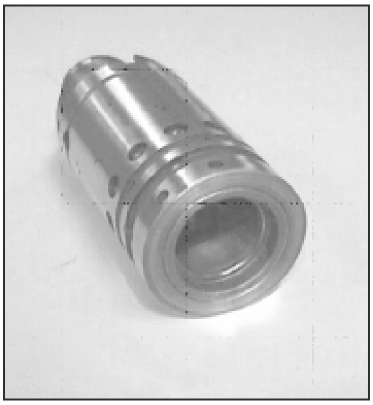


Fig 63

34. Press the springs together and push the neutral position springs into place in the sleeve.

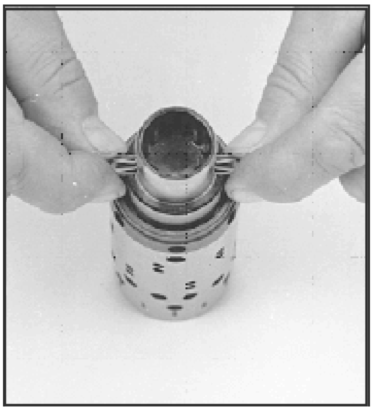


Fig 64

35. Line up the springs and centre them.

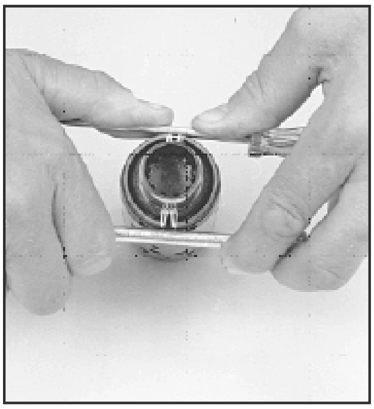


Fig 65

36. Guide the ring down over the sleeve.

__Note:__ The ring should be able to move - free of the springs.

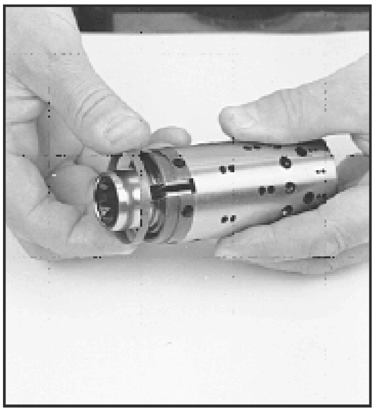


Fig 66

37. Fit the cross pin into the spool/sleeve.

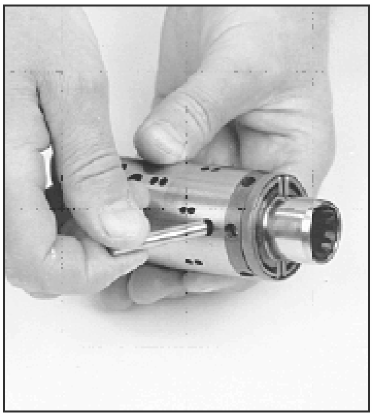


Fig 67

38. Fit bearing races and needle bearing as shown in drawing.

Assembly pattern for standard bearing

1 Outer bearing race
2 Needle bearing
3 Inner bearing race
4 Spool
5 Sleeve

* ***The inside chamfer on the inner bearing race must face the inner spool.***

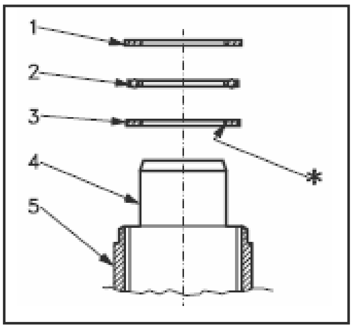


Fig 68

Installation instruction for 'O' rings

Turn the steering unit until the bore is horizontal.Guide the outer part of the assembly tool (SER279) into the bore for the spool/ sleeve.

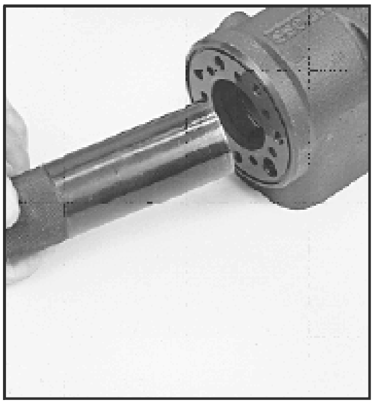


Fig 69

40. Grease o-ring and king-ring/roto Glyd with hydraulic oil and place them on the tool (SER280).

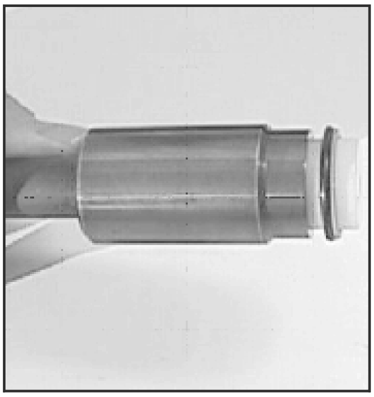


Fig 70

41. Hold the outer part of the assembly tool in the bottom of the steering unit housing and guide the inner part of the tool right to the bottom.

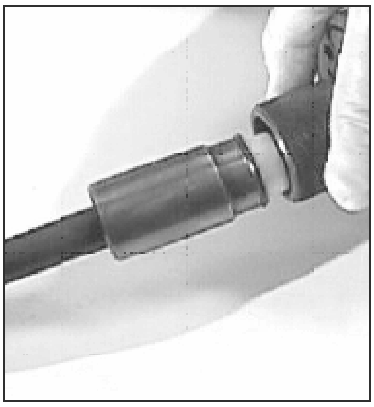


Fig 71

42. Press and turn the o-ring/kin-ring into position in the housing.

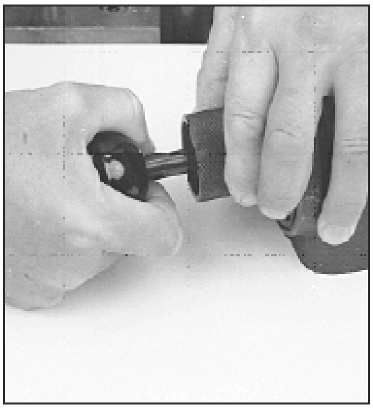


Fig 72

43. Draw the inner and outer parts of the assembly tool out of the steering unit bore,leaving the guide from the inner part in the bore.

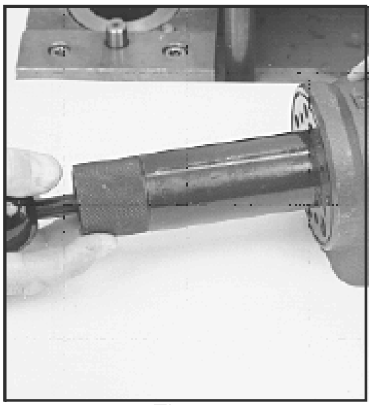


Fig 73

Installation instruction for Lip seal

44. Lubricate the lip seal with dextron oil and place it on the assembly tool (SER 282).

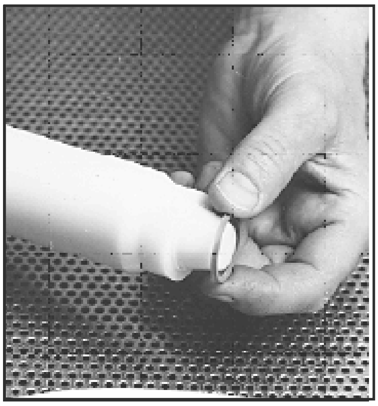


Fig 74

45. Guide the assembly tool (SER282) right to the bottom.

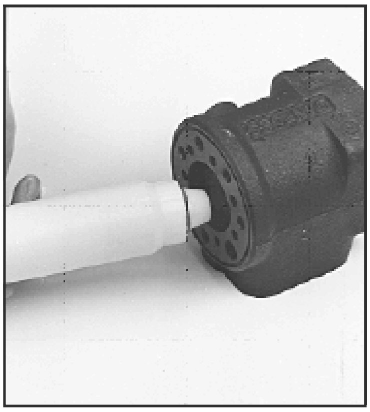


Fig 75

46. Press and turn the lip seal into place in the housing.

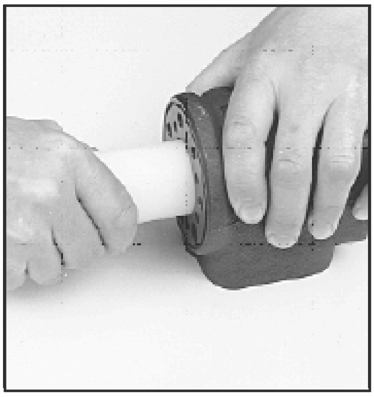


Fig 76

47. With a light turning movement,guide the spool and sleeve into the bore.

    Note: *Fit the spool set holding the cross pin horizontal.*

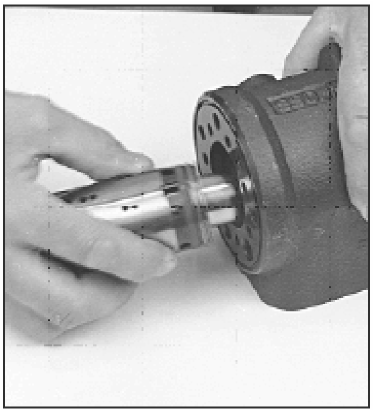


Fig 77

48. The spool set will push out the assembly tool guide (SER281).The o-ring and kin-ring/roto Glyd are now in position.

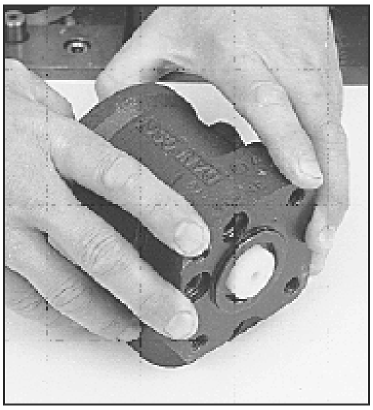


Fig 78

49. Turn the steering unit until the bore is vertical again.Put the check valve ball into the hole indicated by the arrow.

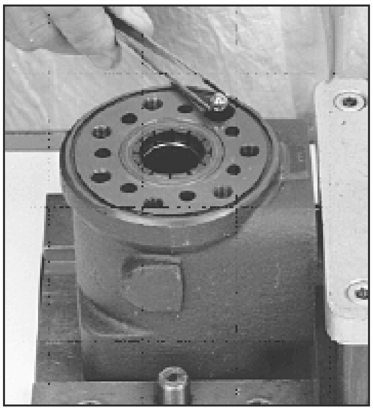


Fig 79

50. Screw the threaded bush lightly into the check valve bore.The top of the bush must lie just below the surface of the housing.

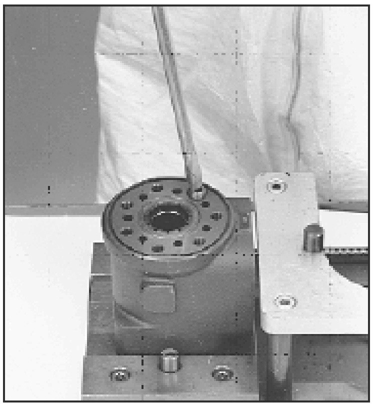


Fig 80

51. Place a ball in the two holes indicated by the arrows.

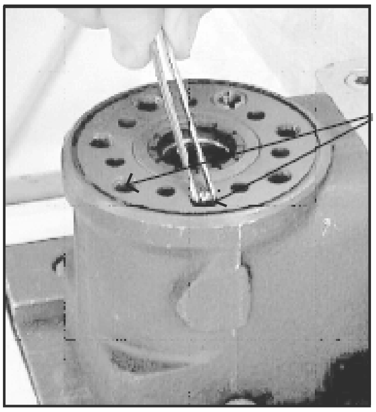


Fig 81

52. Place a new pin in the same two holes.

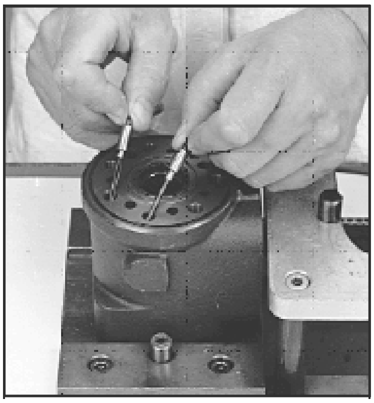


Fig 82

53. In some cases a spring has to be fitted (see page 23 No.8)on the pin before it is placed in the housing.

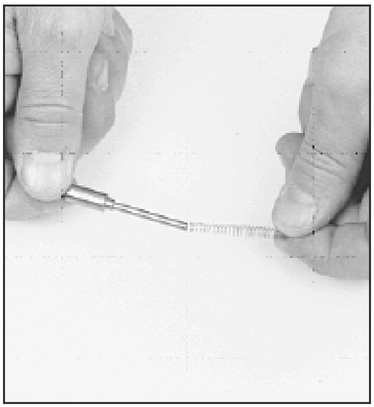


Fig 83

54. Grease the o-ring with mineral oil approx.viscosity 500 mm^2 /s at 68°F (20°C).

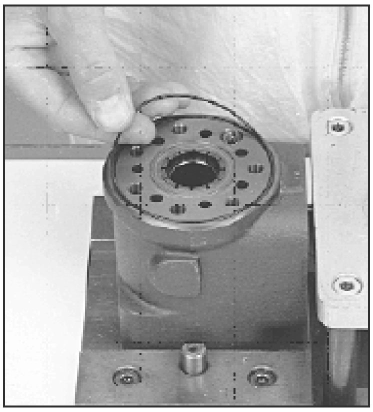


Fig 84

55. Place the distributor plate so that the channel holes match the holes in the housing.

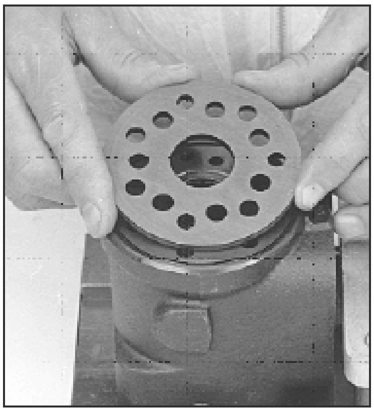


Fig 85

56. Guide the cardan shaft down into the bore so that the slot is parallel with the connection flange.

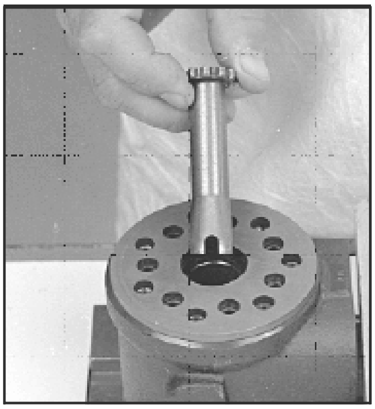


Fig 86

57. Place the cardan shaft as shown -so that it is held in position by the mounting fork by using (SER 283).

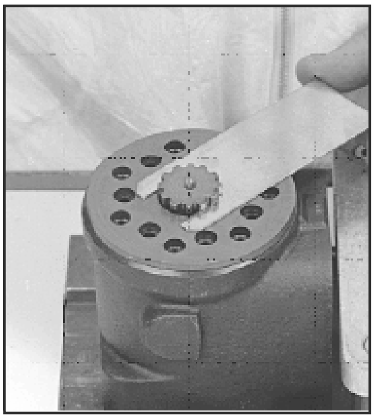


Fig 87

58. Grease the two o-rings with mineral oil approx.viscosity 500 mm 2 /s at 65°F(20°C) and place them in the two grooves in the gear rim.Fit the gearwheel and rim on the cardan shaft.

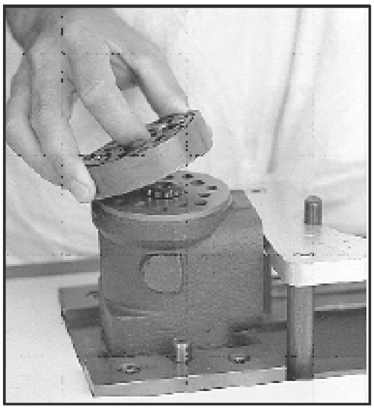


Fig 88

***Important:**Fit the gearwheel (rotor)and cardan shaft so that a tooth base in the rotor is positioned in relation to the shaft slot as shown.Turn the gear rim so that the seven trough holes match the holes in the housing.*

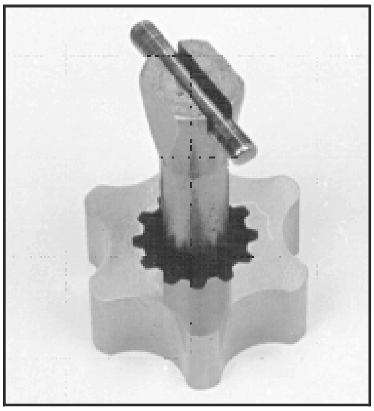


Fig 89

59. Fit the spacer,if any.

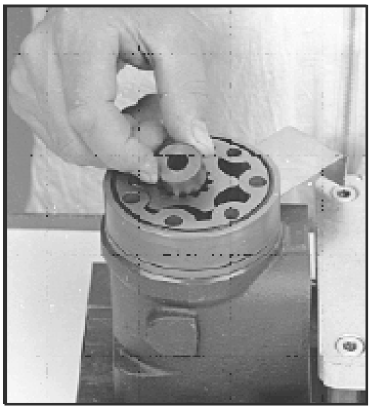


Fig 90

60. Place the end cover in position.

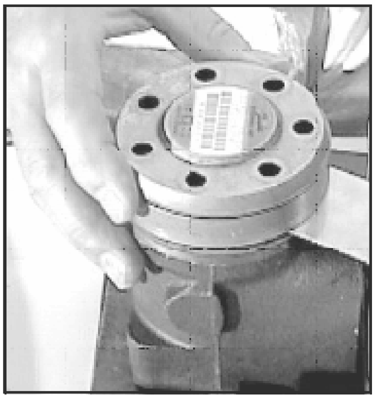


Fig 91

61. Fit the special screw with washer and place it in the hole shown.

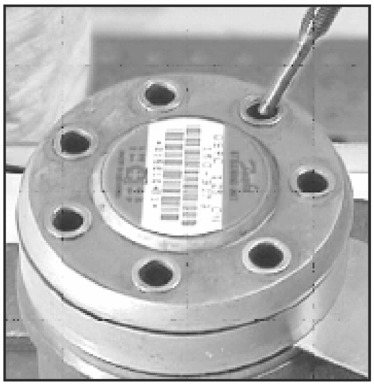


Fig 92

62. Fit the six screws with washers and insert them.Cross-tighten all the screws and the rolled pin with a torque of 22 lbf.ft (30 Nm).

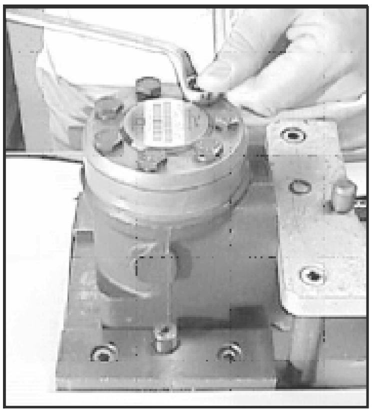


Fig 93

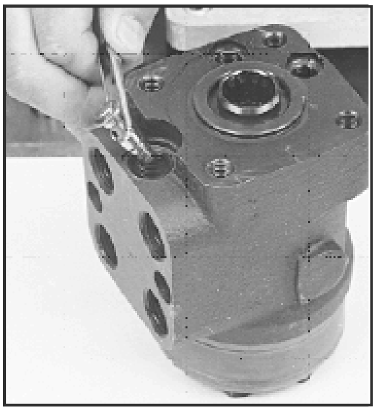


Fig 94

Assembly of pressure relief valve for OSPJ 100 ON

63. Fit the piston.

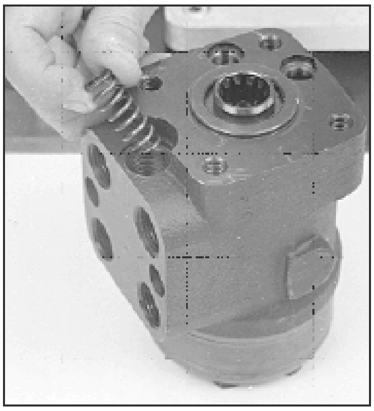


Fig 95

64. Fit the spring.

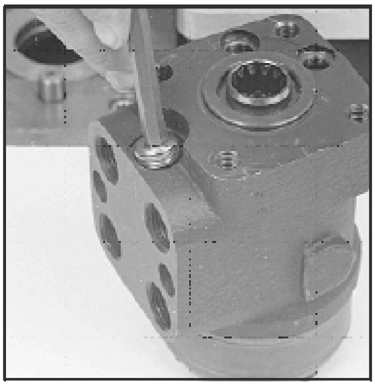


Fig 96

65. Screw in the setting screw with an 8 mm hexagon socket spanner. Make the pressure setting on a panel or the vehicle.

66. Screw plug with dust seal into the housing using an 8 mm hexagon socket spanner. Tightening torque 37 lbf.ft (50 Nm).

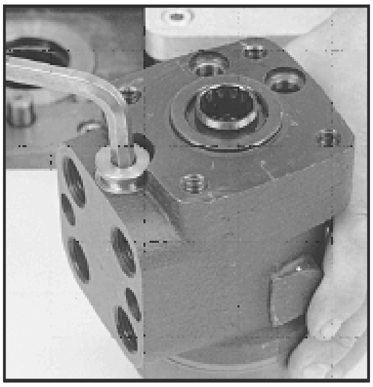


Fig 97

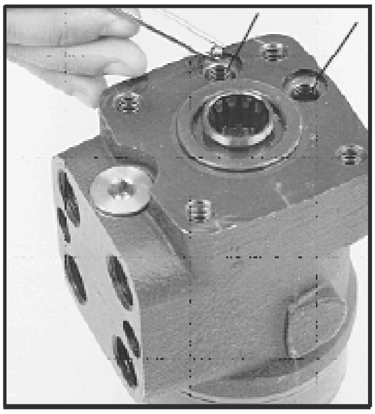


Fig 98

Assembly of shock valves

67. Put a ball in the two holes indicated by the arrows.

68. Place springs and valve cones over the two balls.

    Note:*The blue spring applies to setting range 90-180 bar (1305 - 2610 psi).The untreated spring applies to setting range 170-260 bar (2465 -3770 psi).*

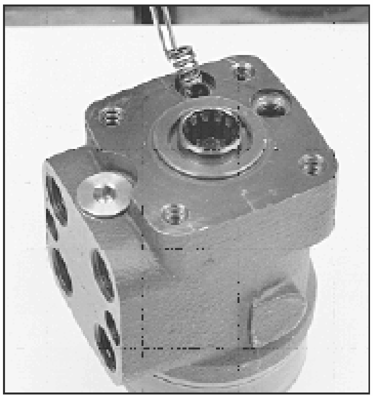


Fig 99

69. Screw in the two setting screws using a 6 mm hexagon socket spanner.Make the pressure setting on a panel or the vehicle.

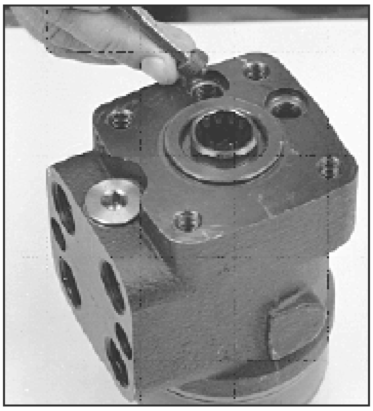


Fig 100

71. Screw plug with seal ring into the two shock valves and tighten them with a torque of 22 lbf.ft (30 Nm) using a 6 mm hexagon socket spanner. Steering unit type OSPJ 100 ON is now assembled.

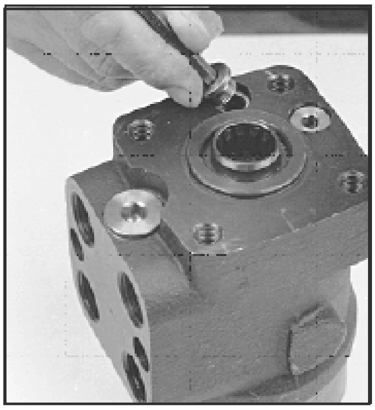


Fig 101

72. Place the dust seal ring in the housing. With the OSPJ 100 ON the dust seal ring must be placed only after the pressure relief valve and shock valves have been fitted.

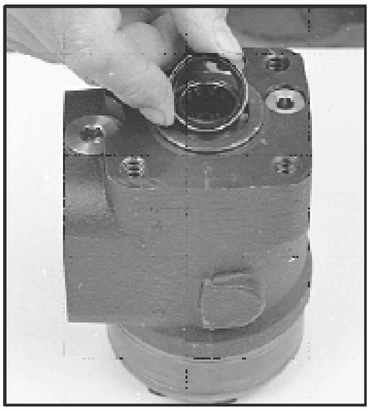


Fig 102

73. Fit the dust seal ring in the housing using special tool SER 284 and a plastic hammer.

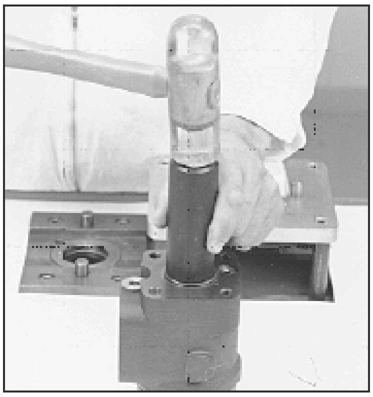


Fig 103

74. Press the plastic plugs into the connection ports.Do not use a hammer.

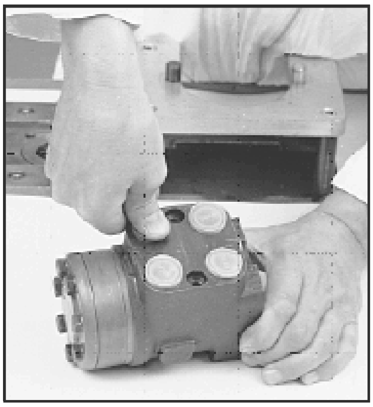


Fig 104

13 A . 9 - DRAG LINKS AND TIE RODS

Overhaul

Dis-assembly

1. Remove the nuts securing the ball joints to the drop arm or spindle arm.
2. Release the ball end by hitting the side of the arm while supporting the opposite side with a block of metal or heavy hammer.
3. Loosen the bolt and locknut and withdraw the ball end.
4. Loosen the clamp bolt and unscrew the ball end.

Examination

Check the ball ends for wear, replacing any defective components. These are safety critical components.

Re-assembly

5. Reverse procedures 1 to 4 except:

a. Tighten the nuts and bolts to the following torque:

i. Ball joint nuts 90 lbf.ft (122 Nm).

ii. Clamp bolt 35 lbf.ft. (47 Nm).

iii. Track adjustment bolt 35 lbf.ft.(47 Nm).

b. Reset the front wheel toe in, see operation 7A . 2 .

13A . 10 - STEERING RAMS

Removal and refitment

Removal

1. Disconnect both hydraulic pipes to the steering ram.
2. Remove the 'R' clip from the inner pivot pin.
3. Remove the split pin.
4. Remove the slotted nut.
5. Drive the ball joint taper out of the steering arm.
6. Remove the steering ram assembly.

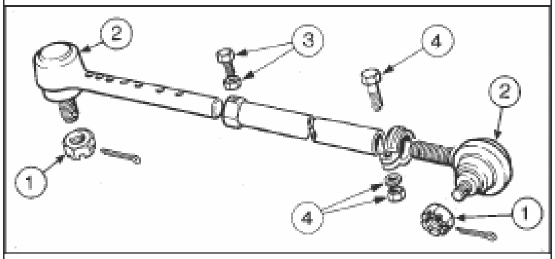


Fig 105

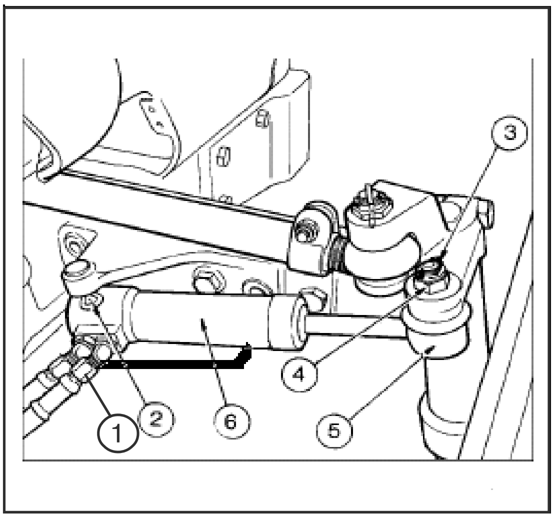


Fig 106

Refitment.

7. Reverse procedure 1 to 6 except:

a. Tighten the ball joint nuts to a torque of 70 lbf.ft (95 Nm) for M16 UNF ball end nuts.

b. Refill the reservoir.

13 A . 11 Steering cylinder

over hauling

Work condition:

It is a must that the system be kept free of dirt or foreign matter in the oil circuit. Cleanliness in servicing this power steering cylinder is absolutely essential.

If it is necessary to disassemble the cylinder, make sure a clean table or work bench is used.

Outside dirt should be cleaned off before disconnecting lines and port holes should be plugged immediately after disconnecting lines.

Finish cleaning off outside dirt before placing on work bench.

When disassembled,parts should be cleaned only in clear clean petroleum base solvent and blown dry with clean dry air. Other solvents may cause deterioration of seals. Avoid wiping parts with cloth.

Warning: It is imperative that the instruction in this manual are followed to the letter.Failure to observe the procedures set out in this manual may result in loss of steering.

Dismantling:

1. Clean the cylinder by wiping the exteriors completely. Open the ports.Hold the cylinder body in one hand and move the piston rod back and forth to purge oil from the cylinder.
2. Hold the cylinder body in bench vise as shown in figure.
3. Unscrew the head end cover from the cylinder body using SER 298.

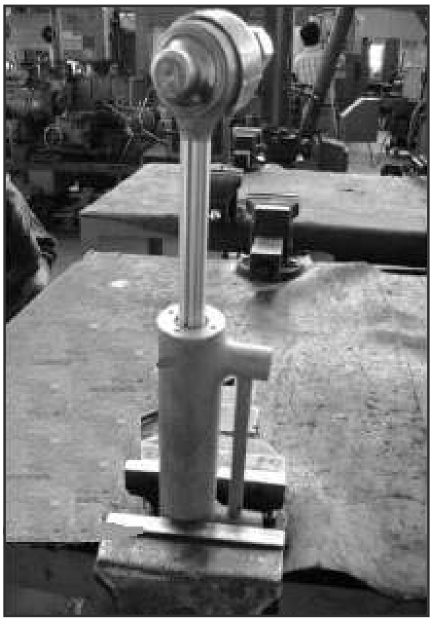


Fig 107

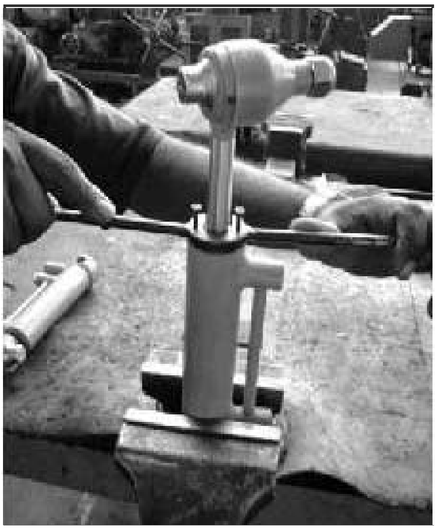


Fig 108

4. Pull out the piston rod sub assembly after completely unscrewing head end cover.

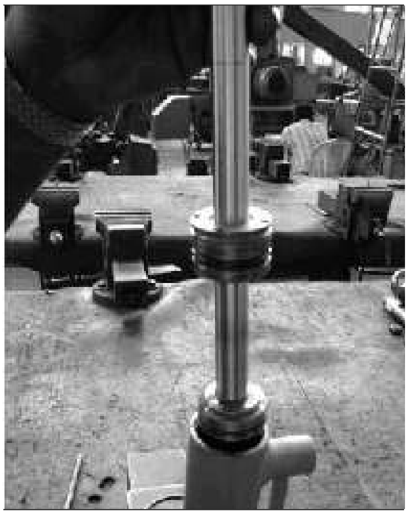


Fig 109

5. Remove piston seal ring using a blunt lever / pry bar.

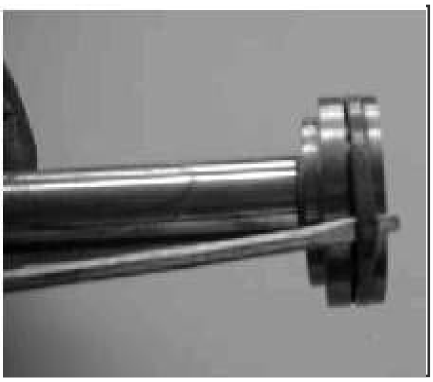


Fig 110

6. Remove piston seal o-ring using a small lever.

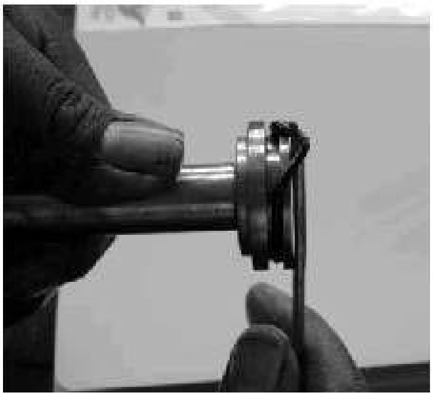


Fig 111

7. Unscrew the grub screw using suitable allen key

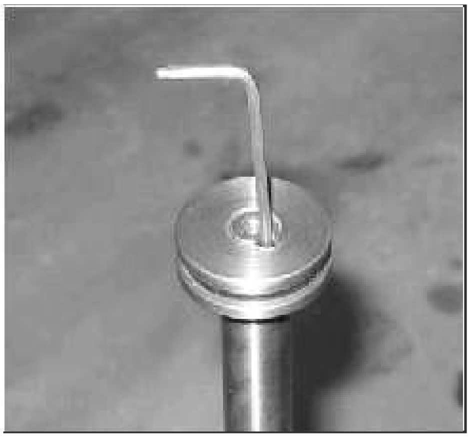


Fig 112

8. Hold the piston in bench vise with proper packing and rotate the ball joint to unscrew the piston.

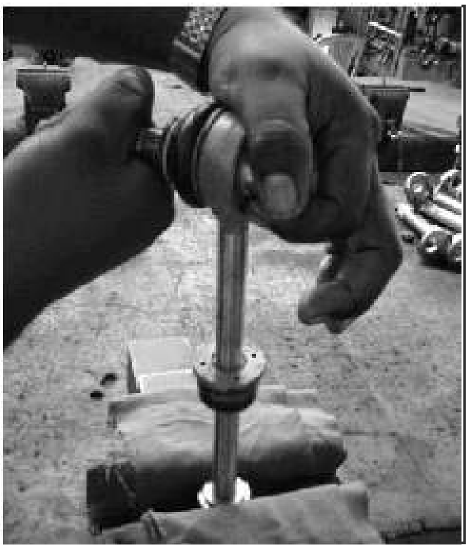


Fig 113

9. Remove the head end cover from piston rod by sliding.

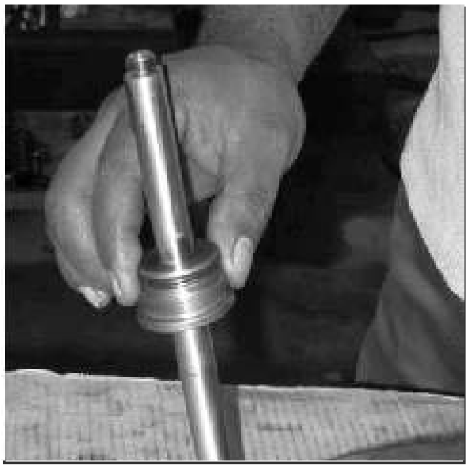


Fig 114

10. Remove the o-ring from head end cover.

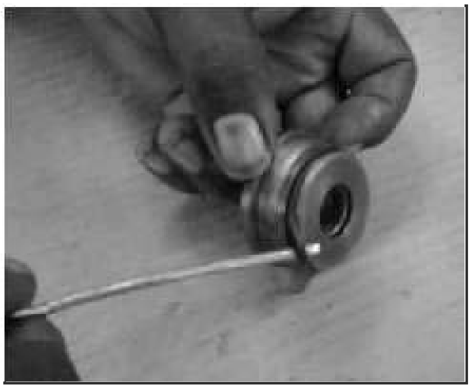


Fig 115

11. Remove the rod seal using a small bent lever / pry bar.

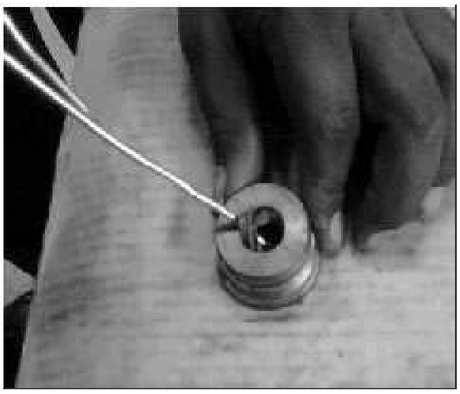


Fig 116

12. Remove the rod wiper using a small bent lever / pry bar.

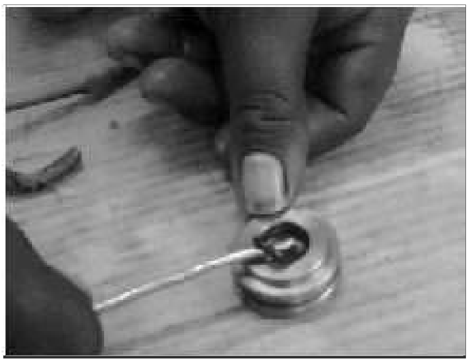


Fig 117

Cleaning:

Clean all parts carefully using clean and clear petroleum based solvent.

Inspection and Replacement:

All seals.o-rings and washers must be replaced.

Check all the parts carefully for any damage or deterioration.If necessary replace the parts with new ones. When in doubt,replace the part.

Lubrication:

Prior to assembly,lubricate all the parts with clean dextron oil.

Refitment:

1. Insert O-ring into piston bore.

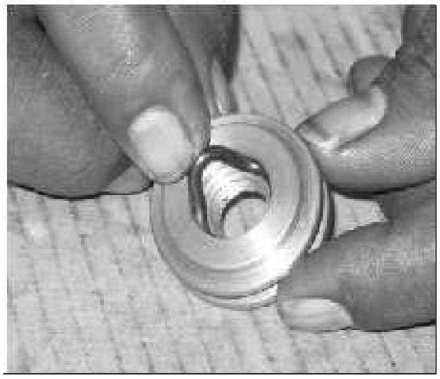


Fig 118

2. Insert rod seal into head end cover bore front side groove.

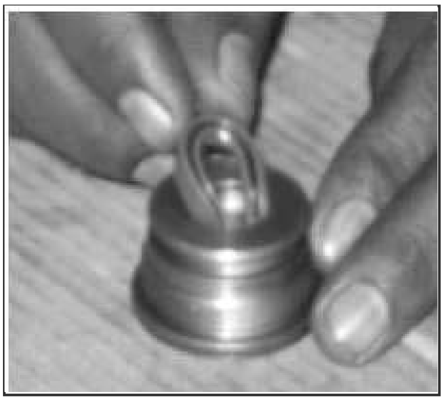


Fig 119

3. Insert rod wiper into head end cover bore bottom side groove.

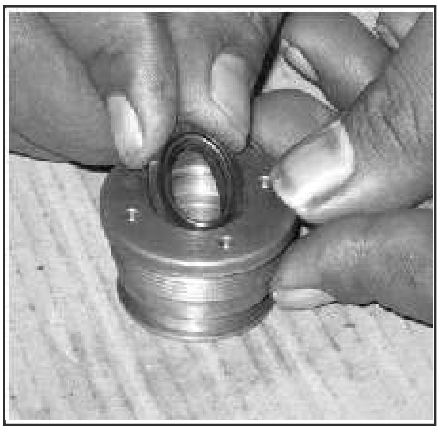


Fig 120

4. Ensure that all seals are properly seated in the respective grooves.

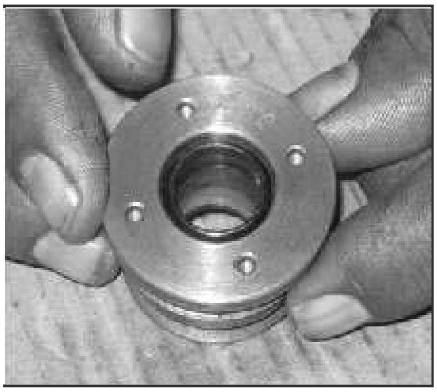


Fig 121

5. Assemble 'O' ring onto the groove on outside diameter of head end cover.

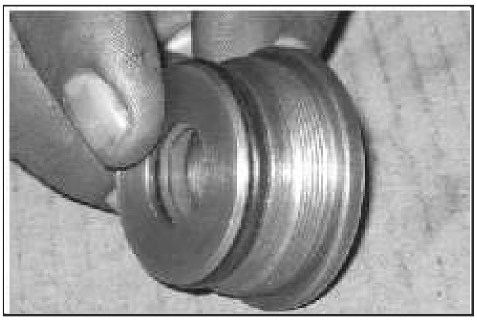


Fig 122

6. Insert head end cover onto the piston by sliding.

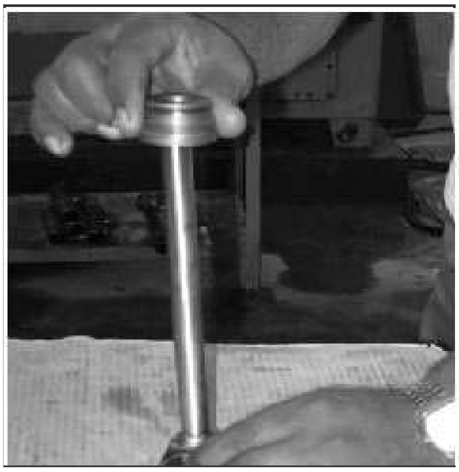


Fig 123

7. Assembling piston and piston rod.

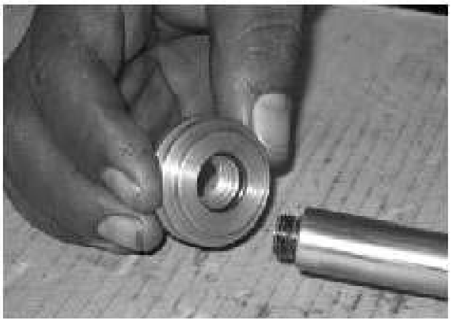


Fig 124

Hold the piston without seal in bench vise with proper care such that the outside diameter does not get damaged.

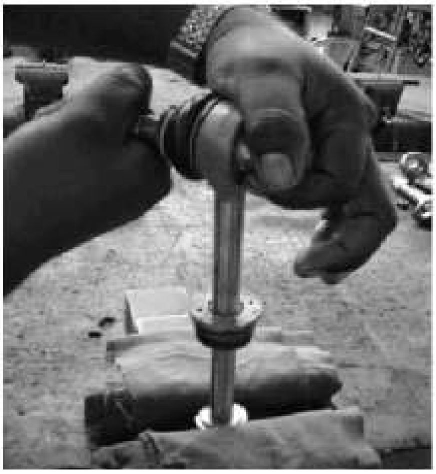


Fig 125

Apply low strength anaerobic thread locking sealant onto the grub screw and insert in to tapped hole in piston face and tighten fully using suitable allen key.

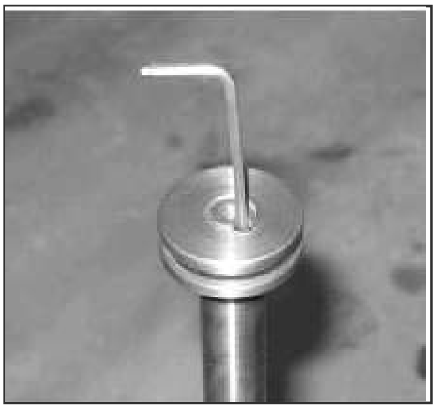


Fig 126

8. Assemble piston seal O-ring onto piston seal groove.

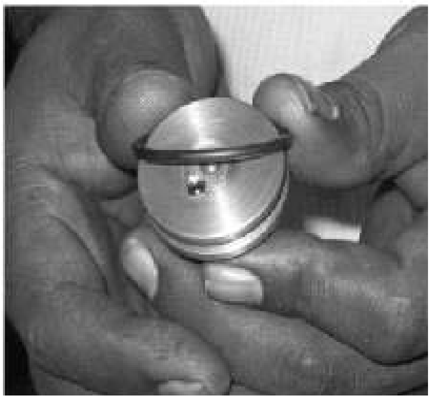


Fig 127

9. Assemble piston seal ring above the O-ring.

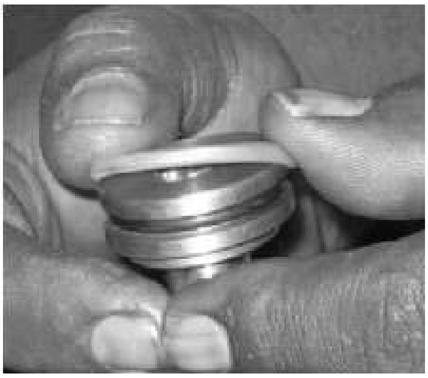


Fig 128

10. Keep piston rod sub assembly separately.

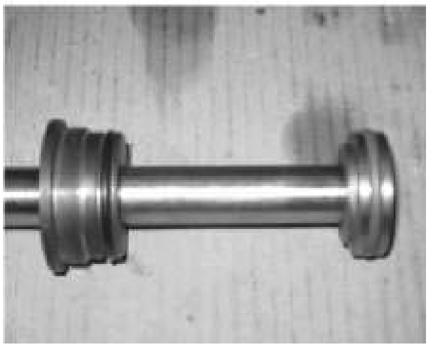


Fig 129

11. Apply oil on all the parts , clamp the tube subassembly at bottom side on the bench vise and insert piston rod sub assembly and ensuring it slides smoothly.

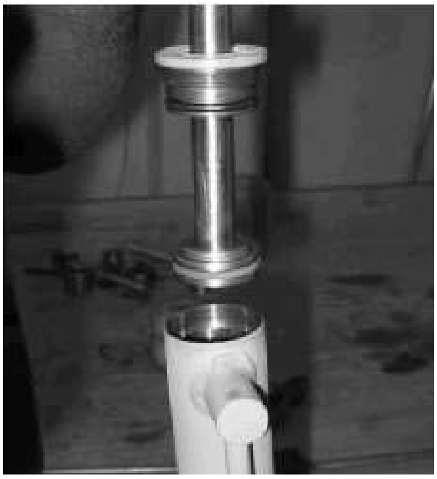


Fig 130

12. Push piston rod subassembly into the tube until it is fully home and that head end cover enters the tube bore.

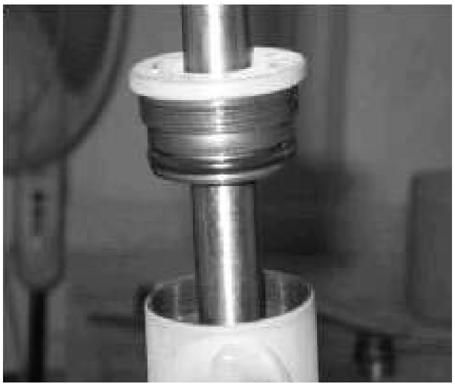


Fig 131

13. Properly engage the head end cover thread with the thread in the tube and tighten completely by using SER 298.
14. Now the cylinder is ready for testing.

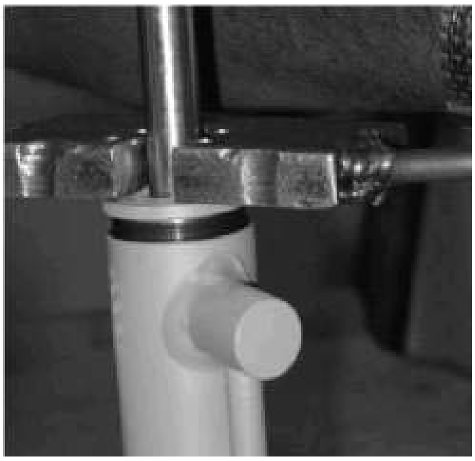


Fig 132

Testing:

1. Hold the cylinder in horizontal position. Remove the port plugs. Move the piston rod in and out five times. The rod should move smoothly.
2. Clamp the cylinder horizontally in a bench vise. Ensure both cylinder ports are open. Connect the rear port of the cylinder to a hand pump fitted with a pressure guage. Actuate the pump by stroking till the piston rods extends out fully. Actuate the pump further till the pressure reaches 125 bar (1812 psi). Hold in that position for 2 minutes. There should be no oil seepage from the front port of the cylinder.
3. Repeat the above exercise by connecting the pump to the front port of the cylinder.There should be no oil seepage from the rear port and head end cover of the cylinder.

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CONTENTS

INTRODUCTION AND SAFETY 1

MISCELLANEOUS DATA 2

TRACTOR IDENTIFICATION AND SPECIFICATIONS 3

SPLITTING THE TRACTOR 4

SHEET METAL 5

ENGINE S3253 .... 6A
ENGINE SJ 327 E 6B

FRONT AXLE 2WD 7A
FRONT AXLE 4WD (TAFE) 7B
FRONT AXLE 4WD (DANA) 7C

DUAL CLUTCH 8A
SPLIT TORQUE CLUTCH 8B

8 X 2 TRANSMISSION 9A
8 X 8 TRANSMISSION 9B
TRANSFER GEARBOX 9C

REAR AXLES DRUM 10A
REAR AXLE OIL IMMERSED BRAKE 10B
BRAKES 10C

LIFT HYDRAULICS 11A
AUXILLARY HYDRAULICS 11B

LIVE PTO 12A
INDEPENDENT PTO 12B

HYDROSTATIC STEERING 13

GENERAL ELECTRICAL 14A
STARTER MOTOR 14B
ALTERNATOR 14C

WHEELS AND TIRES 15

DRAW BAR AND LINKAGES 16

STORAGE CARE 17

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